A COMPARATIVE STUDY OF ULTRASONOGRAPHY AND MR IMAGING FEATURES IN THE DETECTION AND CHARACTERIZATION OF ADNEXAL MASS LESIONS WITH HPE AS A GOLD STANDARD

Dissertation submitted to

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CHENNAI- 600010

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

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MAY 2018

CERTIFICATE

This is to certify that the dissertation **"A COMPARATIVE STUDY OF ULTRASONOGRAPHY AND MR IMAGING FEATURES IN THE DETECTION AND CHARACTERIZATION OF ADNEXAL MASS LESIONS WITH HPE AS A GOLD STANDARD"** titled submitted by **Dr.T.RAMYA** appearing for **M.D(RADIODIAGNOSIS)** degree examination in May 2018 is a bonafide record of work done by her under my guidance and supervision in partial fulfillment of requirement of the Tamilnadu Dr. M.G.R. Medical University, Chennai. I forward this to the TamilNadu Dr. M.G.R Medical University, Chennai.

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DECLARATION

I **Dr. T. RAMYA,** solemnly declare that this dissertation titled **"A COMPARATIVE STUDY OF ULTRASONOGRAPHY AND MR IMAGING FEATURES IN THE DETECTION AND CHARACTERIZATION OF ADNEXAL MASS LESIONS WITH HPE AS A GOLD STANDARD"** is a bonafide work done by me at Govt Kilpauk Medical College, under the supervision of **Dr.P.Chirtrarasan**, M.D., Professor, Govt Kilpauk Medical College. This dissertation is submitted to the Tamil Nadu Dr. M.G.R Medical University, towards partial fulfillment of requirement for the award of M.D. Degree Radiodiagnosis.

Place: Chennai

Date: **Dr. T. RAMYA**

CERTIFICATE - II

This is to certify that this dissertation work titled **"A COMPARATIVE STUDY OF ULTRASONOGRAPHY AND MR IMAGING FEATURES IN THE DETECTION AND CHARACTERIZATION OF ADNEXAL MASS LESIONS WITH HPE AS A GOLD STANDARD"** of the candidate **Dr. T. RAMYA,** Post graduate in **RADIODIAGNOSIS** with registration Number **201518252** for the award of **M.D. RADIODIAGNOSIS** in the **Branch VIII**. I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **7%** percentage of plagiarism in the dissertation.

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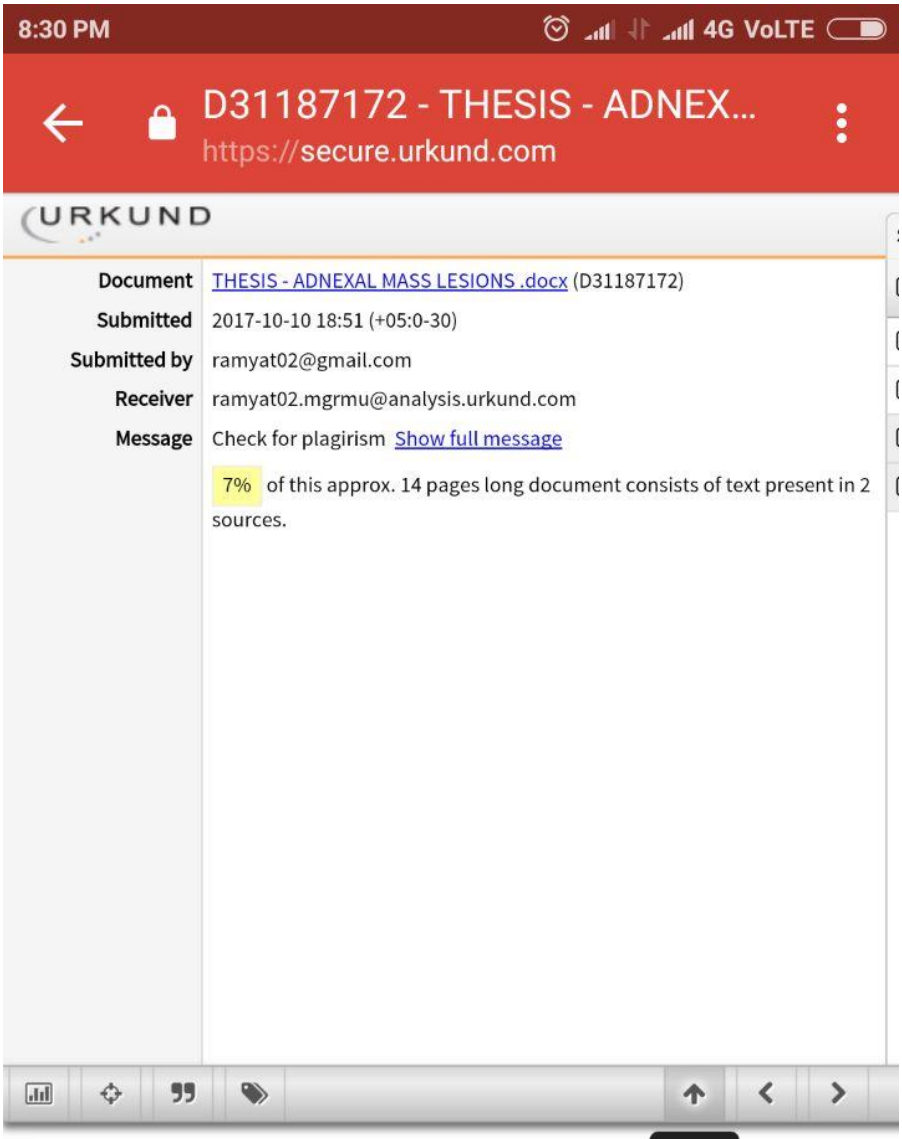

A COMPARATIVE STUDY OF ULTRASONOGRAPHY AND MR IMAGING FEATURES IN THE DETECTION AND CHARACTERIZATION OF ADNEXAL MASS LESIONS WITH HPE AS A GOLD STANDARD INTRODUCTION: Adnexal mass is a lump arising from structures closely related to uterus such as fallopian tube , ovaries and surrounding connective tissue. Adnexal mass can be benign or malignant . Most of the adnexal mass lesions are seen arising from ovaries. Ovarian lesions can be benign lesions or malignant masses. Ovarian malignancy is one of the most common causes of death from gynecologic tumors. Ovarian neoplasm is very rarely detected in early stage and it is far advanced at the time of diagnosis. Detection of ovarian tumor at very advanced stages makes the treatment very difficult. Causes of adnexal mass lesion may be benign or malignant. Benign lesions are simple functional cyst , serous cystadenoma , mucinous cystadenoma , endometriotic cyst , fibroma , thecoma , Brenner tumour

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CONTENTS

INTRODUCTION

Adnexal mass is a lump arising from structures closely related to uterus such as fallopian tube, ovaries and surrounding connective tissue. Adnexal mass can be benign or malignant .(1)

Most of the adnexal mass lesions are seen arising from ovaries. Ovarian lesions can be benign lesions or malignant masses. Ovarian malignancy is one of the most common causes of death from gynecologic tumors. Ovarian neoplasm is very rarely detected in early stage and it is far advanced at the time of diagnosis. Detection of ovarian tumor at very advanced stages makes the treatment very difficult.(2)

Causes of adnexal mass lesion may be benign or malignant. Benign lesions are simple functional cyst, serous cystadenoma, mucinous cystadenoma, endometriotic cyst, fibroma, thecoma, Brenner tumour tuboovarian cyst or hydrosalphinx. Malignant lesions are serous cystadenoarcinoma, mucinous cystadenocarcinoma, endometrotic carcinoma immature teratoma, dysgerminoma, krukenbergs tumor. Cause of adnexal mass lesion varies with different age group.(3)

Incidence of ovarian carcinoma is increasing in recent times. Ovarian ca is responsible for 3.6 % of all cancer cases, with a mortality of 4.3%. It was estimated by “American Cancer Society” and “National

Cancer Institute" that 21,980 new cases of ovarian cancer will be diagnosed approximately every year and 14,270 women will die due to complications of the disease.(1)

Ultrasonography (US), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) can be used to evaluate ovarian mass. The first imaging modality for characterization of adnexal mass lesion is Ultrasonogram. Investigation of choice for adnexal mass is MRI because it gives a better spatial and contrast resolution in delineation of anatomical structures as well as characterization of pathological lesions.(4)

MRI well delineates the abnormalities in female reproductive organs disorders including myomas, ovarian mass lesions, adenomyosis, cervical lesions , endometrial malignancy etc.(5)

Treatment of ovarian carcinoma depends on the stage of the disease, age and severity of symptoms in the patients. Surgery is the primary modality of treatment however many patients require pre or post operative chemotherapy. Surgical treatment may range from optimal debulking surgery to total abdominal hysterectomy with bilateral salphingo oophrectomy. In medical unfit patients initially chemotherapy may be given followed by surgery later. Hormonal therapy is used in patients requiring break from chemotherapy due to intolerance and patients with recurrent lesions without symptoms.(6)

REVIEW OF LITERATURE

ANATOMY OF ADNEXA

Adnexa composed of structures that are closely related structuraly and functionally to the uterus.(7)

Adnexa is made up of Fallopian tube Ovaries Broad ligament.

OVARY: (7)

Each ovary is ovoid in shape and measures approximately 1.5 x 3cm and weighs 2 – 8 grams . Ovaries composed of medulla and cortex.

Cortex made up of ovarian follicles in different stages of development and is embedded in dense fibrocellullar stroma.

Ovarian medulla is highly vascular and receives vessels from ovarian hilum. Tunica albuginea covers the ovary.

Ovarian fossa bounded superiorly by external iliac vessels and anteriorly by obliterated umbilical artery and behind by ureter.

Long axis of ovary oriented in craniocaudal position. Suspensory ligament inserts at superior pole of ovary together with ovarian fimbriae

of fallopian tube. Inferior pole of ovary attatched to uterus by ovarian ligament.

ARTERIAL SUPPLY:(7)

Ovaries had dual blood supply,

1. Ovarian artery originate laterally from aorta, below renal artery.

2. Ovarian branches of uterine artery run in broad ligament to supply ovaries

VENOUS DRAINAGE:

Right ovarian vein drains into inferior vena cava. Left ovarian vein drains into left renal vein. Ovarian veins form a plexus in broad ligament that communicate with uterine venous plexus.

LYMPHATIC DRAINAGE:

Lymphatic drainage into preaortic and lateral aortic lymphnodes.

NERVE SUPPLY

Ovarian plexus is formed by branches from aortic, renal, superior hypogastric and inferior hypogastric plexuses.

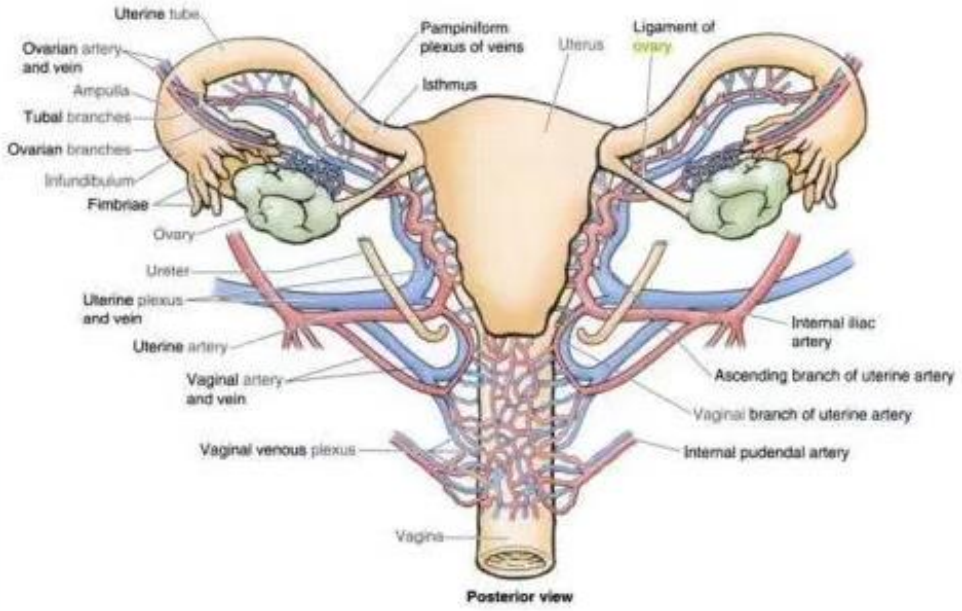
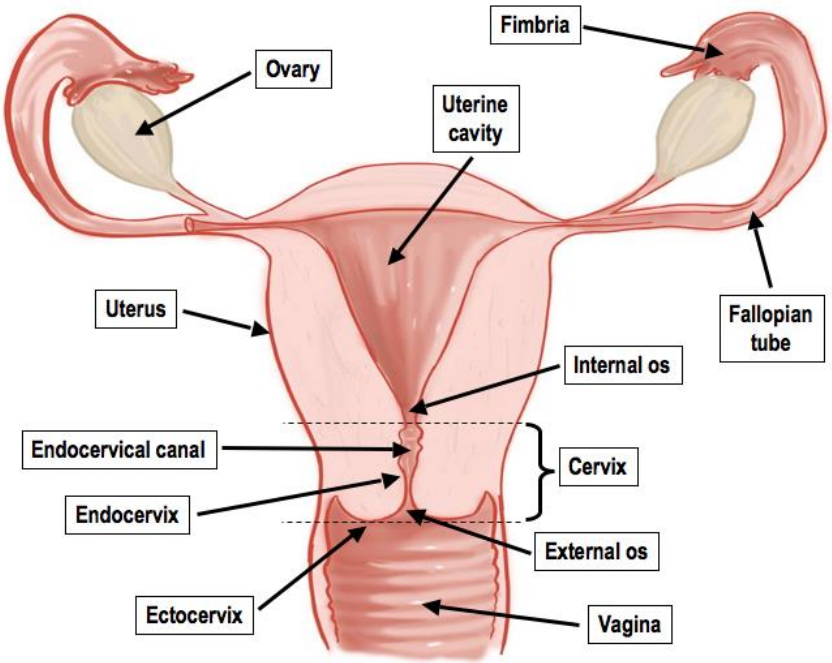


Figure 3.29. Blood supply and venous drainage of uterus, vagina, and ovaries. The broad ligament of the uterus is removed to show the anastomosing branches of the ovarian artery from the aorta and the uterine artery from the internal iliac artery supplying the ovary, uterine tube, and uterus. The veins follow a similar pattern, flowing retrograde to the arteries, but are more plexiform, including a pampiniform plexus related to the ovary and continuous uterine and vaginal plexuses (collectively, the uterovaginal plexus).



FALLOPIAN TUBE:(7,8)

Fallopian tube is 10-12 cm length. It bridges between ovaries laterally and uterus medially. Lateral end of fallopian tube is like funnel called infundibulum. It bears number of finger like process called fimbriae. One of the fimbriae is longer than others called ovarian fimbriae. Ampulla is dilated tortuous tube structure and forms laterl two thirds of the tube. Isthmus is narrow cord like structure forms medial one third of the tube. Interstitial part of the tube lies within the wall of the uterus.

ARTERIAL SUPPLY(7)

Uterine artery supplies medial two third of the tube and ovarian artery supplies lateral one third if the tube.

VENOUS DRAINAGE:

Veins run parallel with arteries and drain into pampniform plexus of ovary and into uterine veins.

UTERUS:(7,9)

The uterus has two parts : body and cervix. The body is the upper expanded portion and forms upper two thirds whereas the cervix is the

lower cylindrical portion which forms the lower one third of the organ. The constriction situated between the body and cervix is called the isthmus

ARTERIAL SUPPLY:

Uterus supplied by - Uterine artery a branch of anterior division of internal iliac artery and ovarian artery

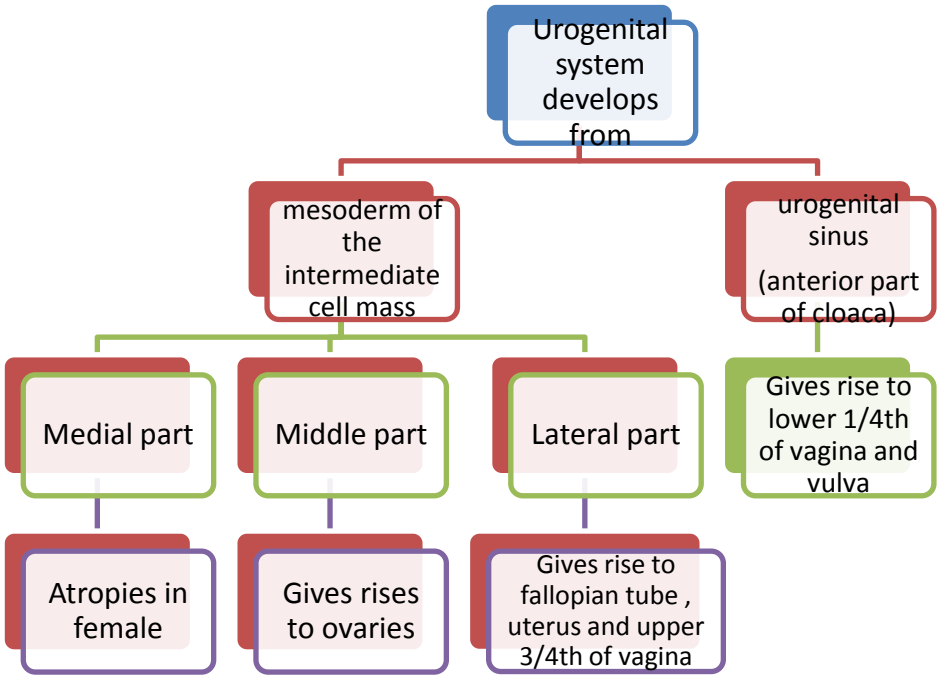
VENOUS DRAINAGE:

Venous plexus drains into internal iliac veins.

LYMPHATIC DRAINAGE:

Lymphatic drainage into internal & external iliac node and sacral lymphnodes.

EMBRYOLOGY OF FEMALE GENITAL TRACT



OVARIES:

The number of ovarian follicles are number limited, and about 300,000 to 2,000,000 are present at birth. They contain a specific reproductive cell, the oocyte, at the primary stage, with 46 chromosomes Of the initial stock of primordial follicles, approximately 300 develop between puberty and menopause to produce fertilizable ova.(10)

Develops from medial part of the genital ridge.

At 4 weeks gestation , primordial germ cells originate from yolk sac then migrate to genital ridge .(11)

At 12 weeks formation of mesentry of ovary as a result of projection of ovary into coelomic cavity.(11)

The ovary descends in the abdominal cavity with 2 ligaments (12)

Ist ligament - Suspensory ligament attatched to cephalic pole - Infundibulopelvic ligament

IInd ligament - Gubernaculum which is attached the caudal end of ovary and the abdominal parities at the inguinal region –

Proximal part – Ovarian ligament

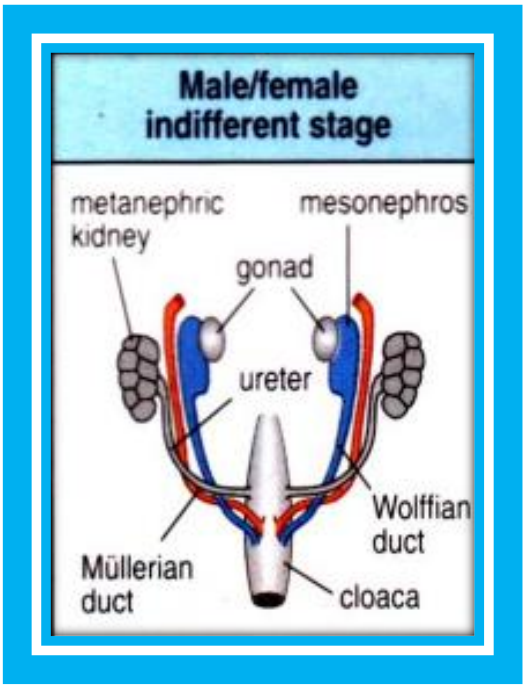
Distal part – Round ligament

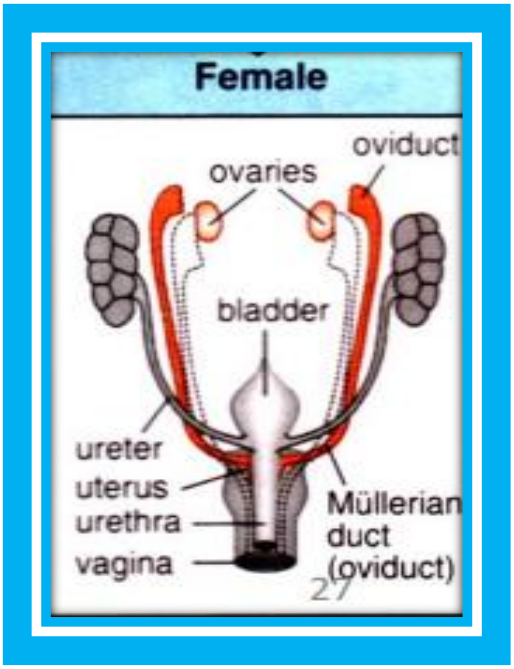
FALLOPIAN TUBE:(11)

Fallopian tube develop from upper parts of mullarain ducts

UTERUS:(11)

Uterus develops from middle part of mullerian ducts after their fusion and canalization.


Male/female
indifferent stage
metanephric
kidney
mesonephros
gonad
ureter
Wolffian
duct
Müllerian
duct
cloaca


Female
oviduct
ovaries
bladder
ureter
uterus
urethra
vagina
Müllerian
duct
(oviduct)

RISK FACTORS

Lifetime risk estimate is two to five times for individuals who have one first degree relative with ovarian cancer (13).

Long-term users of hormone replacement therapy slightly increase ovarian cancer risk (14).

Up to age 60 years of age , 30% lifetime risk of ovarian cancer is conferred due to mutations in the BRCA1 gene (13).

Up to age 70 years of age , 27% lifetime risk of ovarian cancer is conferred due to mutations in the BRCA2 gene(15).

High-grade serous carcinomas show ***p53*** is mutations in 50% or more cases(16).

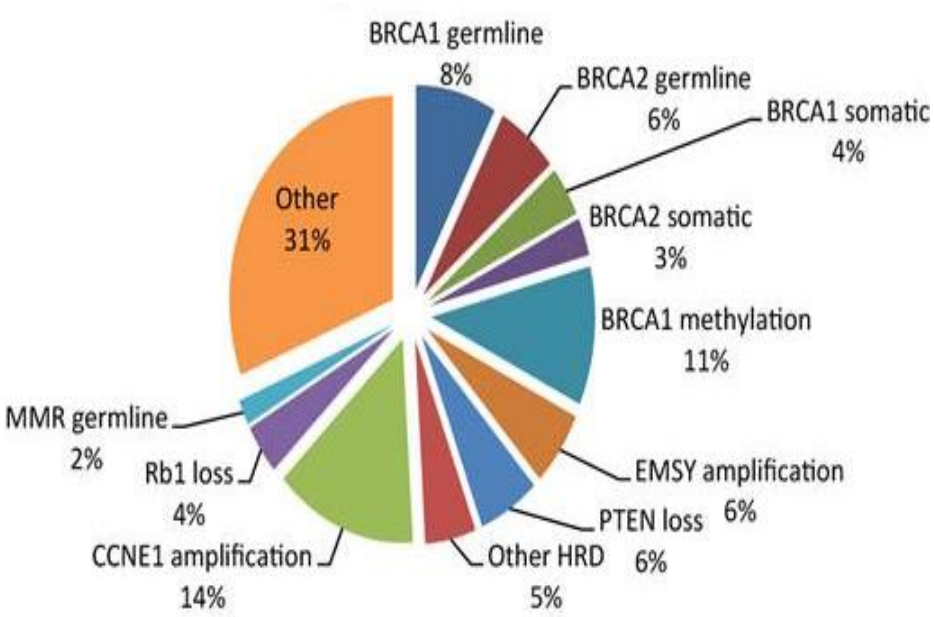
Half of low-grade serous carcinomas shows activating mutation of ***KRAS*** or ***BRAF*** are present (17).

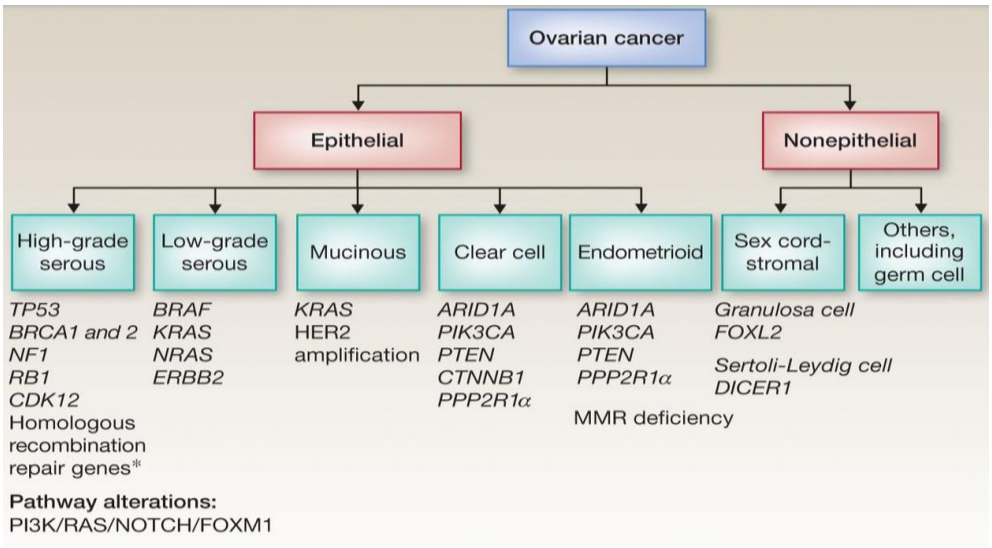
Ovarian serous carcinomas is seen to be associated with mutation of other tumor suppressor genes and oncogenes such as *BRCA1/2*, ***PTEN***, and ***PIK3CA*** *(18)* .

*O*varian serous carcinomas *exhibits* amplification/copy number gains in ***HER2/neu*** (***ERBB2***)(14). 75% of ovarian mucinous carcinomas *shows KRAS* mutation. (19)

Increased risk of ovarian cancer as well as breast cancer is seen in women who have history of e**arly menstruation / late menopause(20).**

80% of malignant ovarian mass patient show increased levels of serum CA-125 levels (>35 U/mL) at radioimmunoassay. CA-125 is not a tumor-specific antigen. CA 125 is also elevated in approximately 1% of healthy control subjects, in patients with liver cirrhosis, endometriosis and pelvic inflammatory disease.(21)





IMAGING IN ADNEXAL LESIONS

ULTRASONOGRAM:

Till date Ultrasonography is the primary imaging modality of choice for pelvic mass evaluation because of its easy availability , cost effectiveness , high sensitivity and absence of ionizing radiation.(22)

COLOR DOPPLER:

Resistive index identified using color Doppler can be used to differentiate benign and malignant neoplasms. Resistive index less than 0.4 is considered suspicious of malignancy(22).

Lack of uniqueness and overlap of findings limits the utility of Color Doppler as a primary modality of investigations for neoplasms(22).

COMPUTED TOMOGRAPHY(23)

Computed tomography has advantages of obtaining thinner sections and better spatial resolution. Because of faster imaging , CT is used for characterization of adnexal mass and staging work-up of ovarian malignancy. Computed Tomography has 79% sensitivity and 75% specificity indicating suboptimal prediction of cytoreduction.(23)

MAGNETIC RESONANCE IMAGING:

In most cases Contrast Enhanced Magnetic Resonance Imaging is of great help in differentiating benign and malignant ovarian mass due to better characterization of tissues and excellent delineation of anatomical structures [24].

Study by Reles et al showed that the sensitivity of Colour Doppler US in premenopausal patients was 80% and specificity only 67%, whereas the sensitivity and specificity were 93% and 83%, in postmenopausal patients respectively (25) .

MR imaging is superior to Doppler US in characterization of malignant ovarian disease (26).

Guerra et al MRI has a higher accuracy of 95% in differentiating between malignant and non-malignant adnexal lesions (27) .

Valentini et al. substantiated the findings of Saini et all about MRI imaging features of malignant adnexal neoplasm. He added that ”heterogeneous and early enhancement pattern of lesion” is also suggestive of malignancy.(28))

MRI serves as a sensitive and specific investigation compared to Doppler ultrasound and contrast enhanced CT in characterization of masses (26). Sonographically indeterminate ovarian mass lesions evaluated with MRI had a sensitivity and specificity of 100% and 94%, respectively (29) .

Borderline ovarian tumors showing early enhancement is a better predictor of malignancy than CA-125 levels and sonographic findings (30).

The following criteria is used for diagnosis of malignant adnexal lesions with MR imaging (31).

Mass size larger than 4 cm

Predominantly solid lesions

Presence of necrosis on contrast-enhanced solid lesions

Contrast-enhanced papillary projections

Septal thickness 3 mm in cystic lesions

Bilaterality

Younger age groups are more prone to develop benign epithelial tumors and these lesions are predominantly cystic in appearance.(32)

Malignant epithelial tumours have major solid components and few cysic structure. The two most common subtypes of epithelial neoplasms are serous and mucinous tumors.(32)

The striking characteristic feature of surface epithelial neoplastic tumor of the ovary is papillary projections.(33)

Hypointense fibrous core with a hyperintense strome that is edematous demonstrated on T2 weighted MR image is a single best predictor of epithelial ovarian tumor. This feature correlates with the aggressive nature of the tumor.(33)

Benign epithelial tumors:(34)

Diameter less than 4 cm,

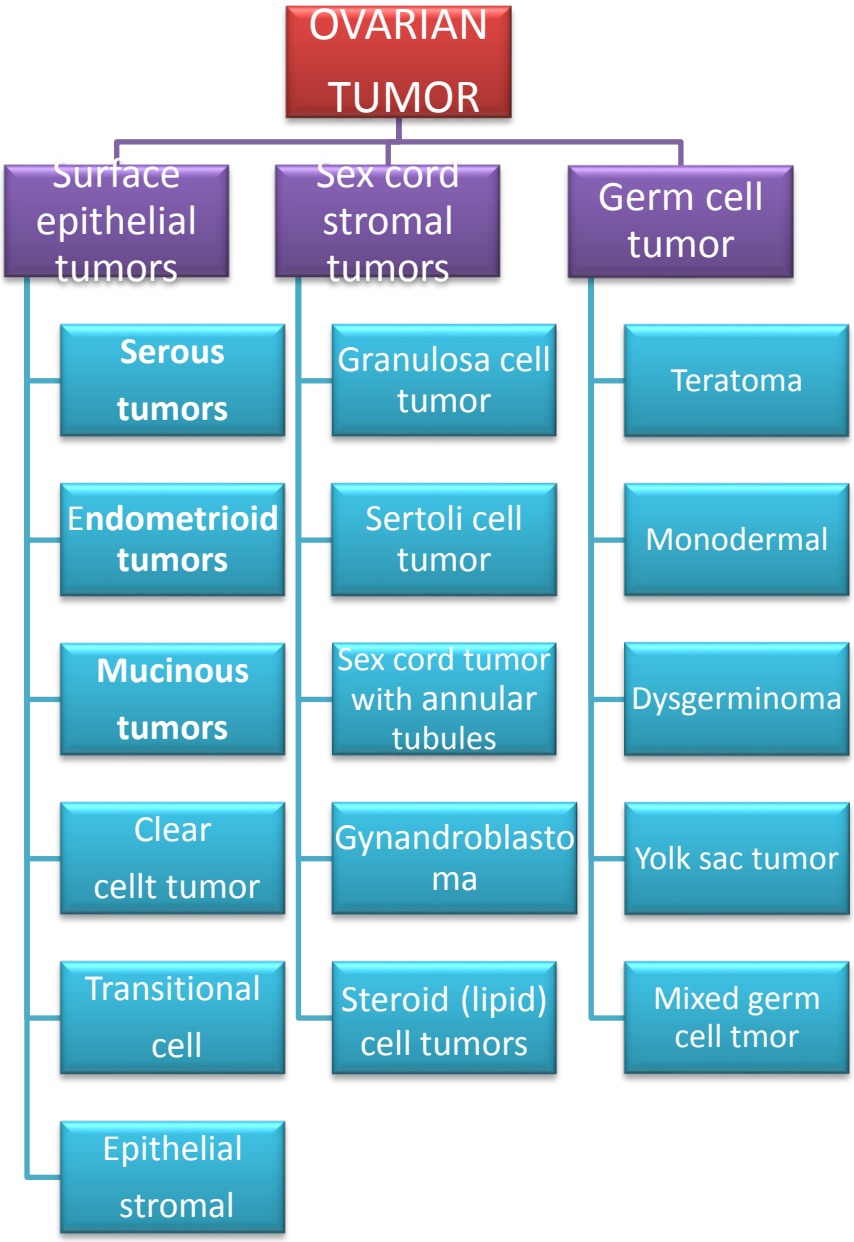
Entirely cystic components

Wall thickness less than 3 mm

Lack of internal structure

Absence of both ascites

CLASSIFICATION OF OVARIAN TUMOR(35)



WHO CLASSIFICATION OF OVARIAN TUMORS (35)

SURFACE EPITHELIAL - STROMAL TUMORS

Serous tumors:

Benign (cystadenoma)

Borderline tumors (serous borderline tumor)

Malignant (serous adenocarcinoma)

Mucinous tumors, endocervical-like and intestinal type:

Benign (cystadenoma)

Borderline tumors (mucinous borderline tumor)

Malignant (mucinous adenocarcinoma)

Endometrioid tumors:

Benign (cystadenoma)

Borderline tumors (endometrioid borderline tumor)

Malignant (endometrioid adenocarcinoma)

Clear cell tumors:

Benign

Borderline tumors

Malignant (clear cell adenocarcinoma)

Transitional cell tumors:

- Brenner tumor
- Brenner tumor of borderline malignancy
- Malignant Brenner tumor
- Transitional cell carcinoma (non-Brenner type)

Epithelial-stromal:

- Adenosarcoma
- Carcinosarcoma (formerly mixed Mullerian tumors)

SEX CORD - STROMAL TUMORS

Granulosa tumors:

- Fibromas
- Fibrothecomas
- Thecomas

Sertoli cell tumors:

- Leydig cell tumors
- Sex cord tumor with annular tubules
- Gynandroblastoma
- Steroid (lipid) cell tumors

GERM CELL TUMORS

Teratoma:

Immature

Mature

Solid

Cystic (dermoid cyst)

Monodermal (e.g., struma ovarii, carcinoid)

Dysgerminoma

Yolk sac tumor (endodermal sinus tumor)

Mixed germ cell tumors

MALIGNANT, NOT OTHERWISE SPECIFIED

Metastatic cancer from nonovarian primary:

Colonic, appendiceal

Gastric

Breast

STEPS IN DISSEMINATION

Ovarian cancer will affect the body in three different stages:(35,23)

ATTACK: Malignant ovarian tumor grows rapidly and attacks the healthy organs adjacent to it like uterus and fallopian tubes.

EXPAND: Malignant cells are prone to break from the main tumor and there is high likelihood of seeding of malignant cells in abdomen and there by forming new tumors.

SPREAD: The propensity of spreading to the anatomical landmarks like chest , pelvis and abdomen increases when the malignant cells gets broken away and enters the lymphatic system. Haematogenous entry may cause dissemination to liver and lungs.

Some researches call ovarian tumor as “silent killer” because of the lack of perceptible symptoms until the late stages of the disease.

Nature of serous ovarian neoplasms:(36)

Type of serous ovarian neoplasm	Percentage
Low malignant potential	15%
Benign cystadenoma	60%
Malignant cystadenoma	25%

Nature of mucinous ovarian neoplasms:(36)

Type of mucinous ovarian neoplasm	Percentage
Low malignant potential	10 to 15%
Smooth walled Benign cystadenoma	80%
Highly malignant potential	5 - 10%

Serous cystadenoma:

Serous cystadenoma is unilocular most of the times with a thin wall measuring less than 3mm . (37)

T1 and T2 weighted images of serous cystadenoma shows low signal intensity and homogenous high signal intensity respectively. These lesions does not show significant post contrast enhancement.(37)

They are smaller than mucinous cystadenoma. Bilaterality is a common finding in serous cystadenoma.(37)

Mucinous cystadenoma:

Mucinous cystadenoma appears larger in size compared to serous cystadenoma.(37)

Mucinous cystadenoma gives honeycomb like appearance due to multiple locules (multilocular) with multiple thin regular septations and wall which lacks endo or exocytic vegetation on Ultrasonogram or MRI.

These does not show significant enhancement after contrast administration.(37)

Granulosa cell tumours

Mostly benign

Manifest by producing hormones with hyperestrogenism.

There are two main subtypes of Granulosa cell tumours namely adult and juvenile types. (37)

Hyperestrogenism results in endometrial hyperplasia , atypical bleeding and pseudoprecocity.(37)

Granulosa cell tumours mostly appears as both cystic and solid masses, but it can be multilocular cystic or a predominantly solid lesions.(37)

Yolk sac tumour / endodermal sinus tumour:

Constitutes 1 % of ovarian tumors.

Presents in the second or third decade

Appears as a large mixed lesions with both cystic and solid component

Bright dot sign due to foci of enhancement due to dilated vessels due to increased vascularity.(38)

***Brenner tumour* /** transitional cell tumour

Represents 2 % of ovarian neoplasms.

Mostly benign.

Due to solid fibrous component Brenner tumor shows low signal intensity on T2-weighted image.

Very rarely areas of calcification can be present within the solid components of Brenner tumour and hence MRI demonstrates a lesion with both cystic and solid components .(39)

Dysgerminoma:

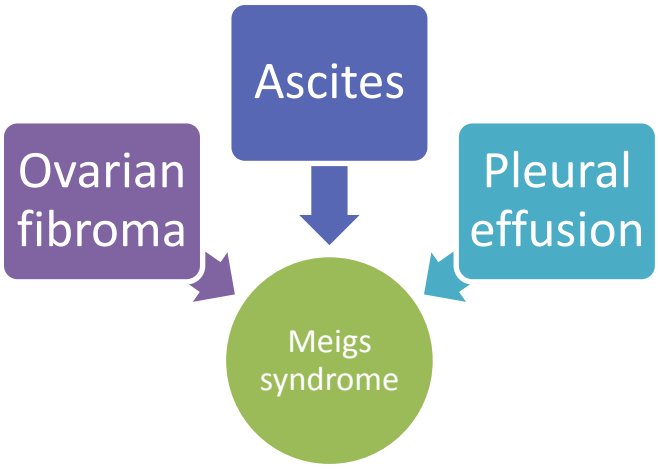
Dysgerminoma is seen as lobulated solid lesion with fibrovascular septa and a surrounding fibrotic capsule.

On T2-weighted images solid component shows intermediate to high signal intensity, whereas the septa shows low signal intensity, but there is significant enhancement on contrast administration.(38)

Sex cord stromal tumours:

Sex cord-stromal tumours includes *fibromas,thecomas and fibrothecomas* These are the most common benign solid lesion of the ovaries.(39)

Fibrothecomas consist of both fibrous tissue and lipid containing theca cells. Usually seen as a well-circumscribed mass with predominantly solid component showing T1-weighted low to intermediate signal intensity and T2-weighted low signal intensity. (40)



***Sertoli-Leydig cell tumours*:** (38,41)

0.5 % of ovarian tumours

Responsible for hyperandrogenism

Most common virilizing tumours.

Young women are mostly affected and they show signs of increased androgen activity.

Sertoli-Leydig cell tumours are mostly solid lesions but they may also present as lobulated heterogeneous lesions with both cystic and solid components.(41)

These does not show significant enhancement after contrast administration.(38)

Teratoma:

Mature cystic teratoma constitutes tissues of all the three layers of embryogenic germ cells.Most commonly seen in women less than 45years of age. (37)

Composed of hair follicle, sebaceous material, skin glands and muscles. Rokitansky nodule is a raised protuberance seen within the cyst containing hair, bone and teeth.(37)

Endometroid carcinoma:

10%-15% of ovarian carcinoma is Endometroid carcinomas.(42)

They are the most common malignant neoplasm arising within endometriosis (42)

Endometrioid tumors are bilateral in 30%-50% patients. Endometrial hyperplasia is expected to have association with endometrioid carcinoma.(42)

Clear cell carcinoma: (43)

Represents 5% of ovarian malignancies.

Mostly seen in patients having endometriosis.

On imaging it appears as a unilocular cyst or large cyst protrusions which are solid in nature.

Lesion demonstrates minimal post contrast enhancement.(43)

Ovarian metastasis (44)

Constitutes 5 % of malignant ovarian tumours

Most common primaries to metastasize to ovary are Stomach, colon, breast, lung and contralateral ovary.

Modes of spread :

direct invasion

transcoelomic dissemination

hematogeneous spread

lymphatic spread

Krukenberg tumours (44)

Metastatic lesions to the ovary from a gastrointestinal cancer.

The classical feature of Krukenberg tumor is the presence of mucin-producing signet-ring cells.

Mostly bilateral with a cystic and solid or a predominantly solid component.

Gadolinium administration shows enhancement of cyst wall and enhancement of the solid component.

Hydrosalphinx:(45)

Fluid filled fallopian tube *is called Hydrosalpinx*.

Distension of fallopian tube with pus / blood is called as pyosalphinx and haematosalphinx respectively.

Pyosalpinx show high signal intensity on diffusion-weighted images and hematosalpinx exhibit high signal intensity on T1-weighted images.

Features of functional cyst:(33)

Thin walled (< 3 mm)

Unilocular

Presence of posterior acoustic enhancement(33)

Endometriotic cysts / endometriomas / chocolate cysts: (46)

bilateral

cystic to complex adnexal masses with

high signal intensity on T1-weighted and

intermediate to low signal intensity on T2-weighted images.

“Shading sign” - Gradual loss of signal intensity caused by repeated bleeding within the cyst in T2 weighted sequences.(46)

Tubo- ovarian abscess:(47,48)

Acute pyogenic infection of female genital tract

Imaging features:

Thick walled fallopian tube

Enlarged edematous ovaries with fluid distended fallopian tube and inflammatory changes in pelvic structures.

Usg:

Multilocular / unilocular complex thick walled cystic adnexal mass.

MRI:

Ill defined adnexal mass with thick irregular walls containing fluid ,which appears hypointense in T1 and hyperintense in T2 sequence.

Post contrast MRI shows intense enhancement of the lesion.

STAGING OF OVARIAN CARCINOMA (49)

FIGO Staging of ovarian carcinoma

Stage I: Tumour limited to ovaries

Ia – Tumor limited to one ovary,capsule intact, no tumor on ovarian surface,no malignant cells in ascites or peritoneal washings

Ib- – tumor limited to both ovaries, capsule intact, no tumor on ovarian surface,no malignant cells in ascites or peritoneal washings

Ic- Tumor limited to one or both ovaries with any of the following:capsule rupture, tumor on ovarian surface , malignant cells in ascites or peritoneal washings

Stage II: Tumor involves one or both ovaries with pelvic extensions or implants

IIa- tumor involves uterus or fallopian tubes,no malignant cells in ascites or peritoneal washings

IIb- Tumor involves other pelvic tissues, no malignant cells in ascites or peritoneal washings

Stage III: Tumor involves one or both ovaries with microscopically confirmed peritoneal metastasis outside the pelvis

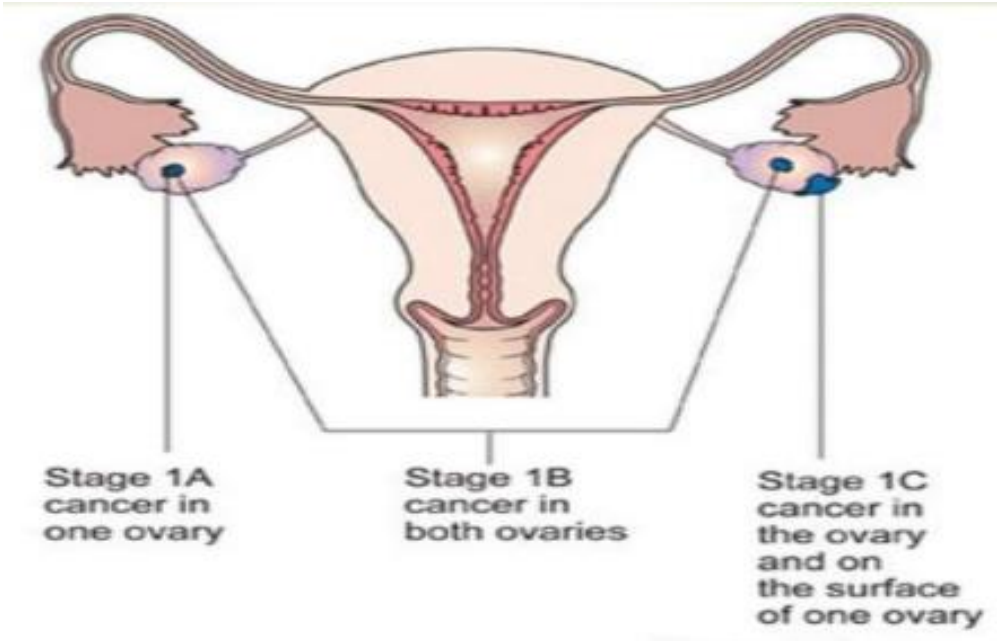
IIIa – Microscopicaly confirmed peritoneal metastasis outside the pelvis

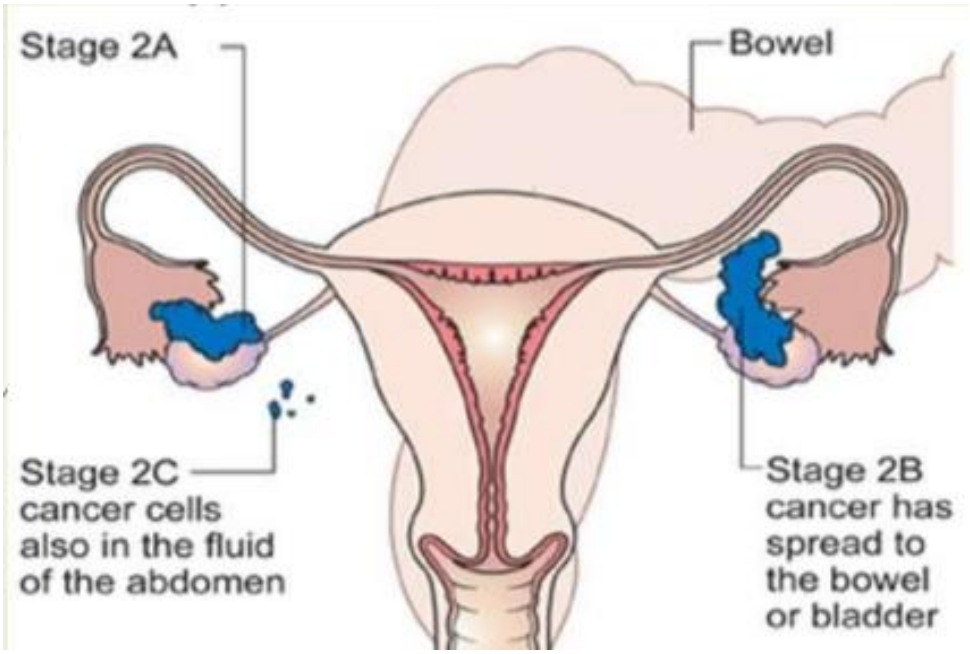
IIIb – Macroscopicaly peritoneal metastasis outside the pelvis < 2cm

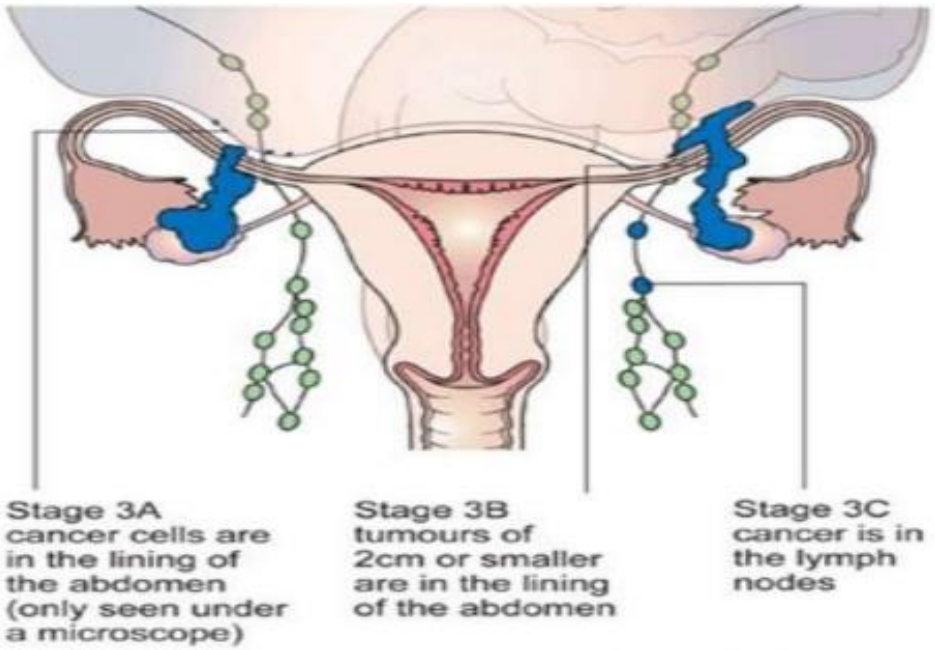
IIIc – Macroscopicaly peritoneal metastasis outside the pelvis >2cm

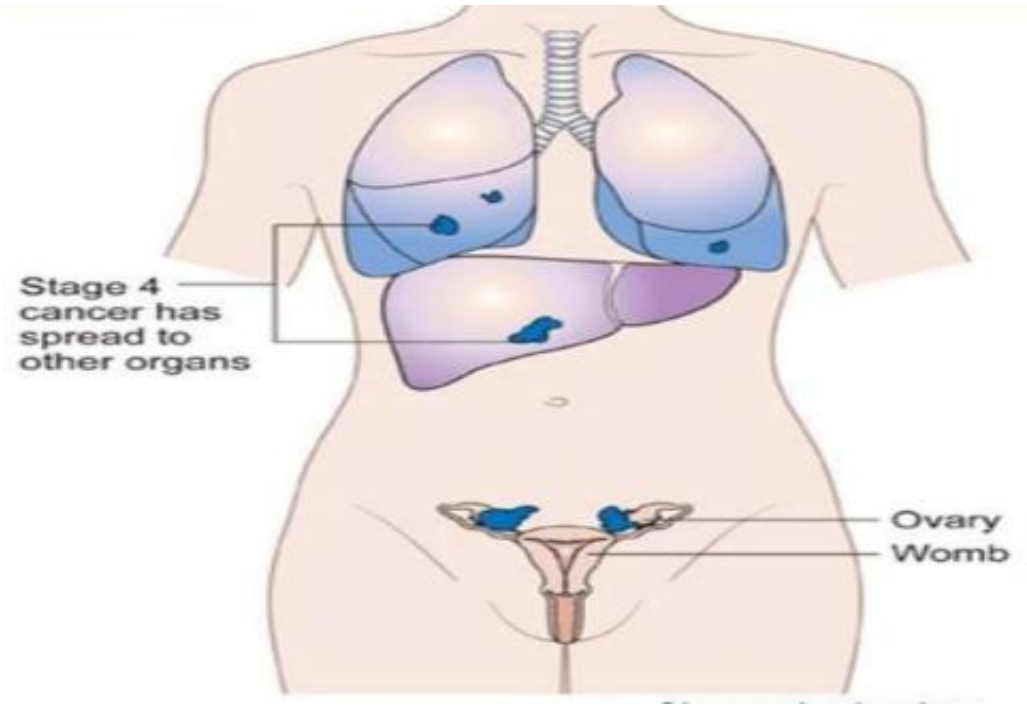
Stage IV: Distant metastasis beyond the peritoneal cavity

Enlarged lymphnodes above renal hilum


Stage 1A
cancer in
one ovary
Stage 1B
cancer in
both ovaries
Stage 1C
cancer in
the ovary
and on
the surface
of one ovary


Stage 2A
Bowel
Stage 2C
cancer cells
also in the fluid
of the abdomen
Stage 2B
cancer has
spread to
the bowel
or bladder


Stage 3A
cancer cells are
in the lining of
the abdomen
(only seen under
a microscope)
Stage 3B
tumours of
2cm or smaller
are in the lining
of the abdomen
Stage 3C
cancer is in
the lymph
nodes


Stage 4
cancer has
spread to
other organs
Ovary
Womb

TREATMENT

STAGE	TREATMENT
I	Primary cytoreduction
II	Primary cytoreduction
III	Neoadjuvant chemotherapy and interval cytoreduction
IV	Neoadjuvant chemotherapy

Treatment of ovarian cancer depends on the stage of the cancer that is a reflection of spread of the lesion to distant or adjacent site.

Most commonly 2 forms of treatment of ovarian cancer is used.(50)

1. Primary choice is surgery in which cancer is removed from the ovary and from as many other sites as possible.

2. Chemotherapy

The main objective of surgery is confirmation the diagnosis by sending the specimen for HPE, define the extension of disease, and

resection of all visible tumor. The decision of appropriate surgical approach depends largely on the extension of lesion and requirement to retain the fertility.

CYTOREDUCTIVE SURGERY(51)

Reduction of as much tumor volume as possible y surgical removal is known as cytoreduction or cytoreductive surgery.

INTERVAL DEBULKING SURGERY(51)

Interval debulking surgery is defined as a second operation performed after 3 or 4 cycles of platinum chemotherapy in woman who had suboptimal debulking primary surgery

LAPAROSCOPIC SURGERY(52)

Laparoscopic surgery is used for diagnostic purposes in low risk patients for ovarian cancer and removal of cystic masses in patients who meets the following criterion.

Size of the mass lesion less than 10cm recorded sonographically

Absence of solid components

Ascites should be absent

Normal CA – 125 values

Absence of family history of ovarian malignancy.

CHEMOTHERAPY(51)

Very few patients with ovarian carcinoma are successfully treated with surgery alone. Rest of the patients require chemotherapy either before or after the surgery.

INTRAPERITONEAL CHEMOTHERAPY(51)

Instillation of chemotherapeutic agents into peritoneal cavity .

Advantages :

No risk of systemic adverse effects

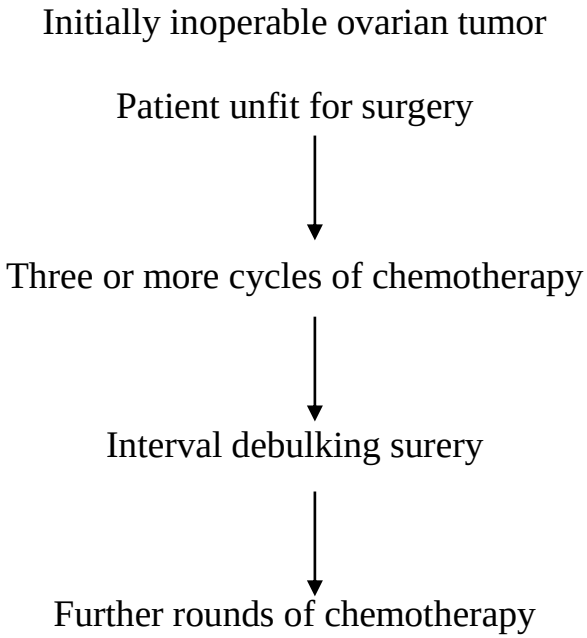
Ability to attain high concentration at the local site

Disadvantages :

Inability to penetrate more than few millimeters from the site of instillation.

Infection / block of the subcutaneously placed tube for instillation of drugs.

NEOADJUVANT CHEMOTHERAPY



MAINTANENCE CHEMOTHERAPHY(52)

50% of patients show recurrence even after complete resection of the tumor and chemotherapy. In order to prevent the recurrence , strategies were developed in maintanence therapy using niraparib.

DRUGS USED IN CHEMOTHERAPY(51)

Paclitaxel / Docetaxel

Cisplatin / Carboplatin

Doxorubicin

Bevacizumab

Olapraib / Rukaparib / Niraparib

Pazopanib

AIMS AND OBJECTIVE

To assess and compare the accuracy of ultrasonography and MR imaging features in the detection and characterization of adnexal mass lesions with HPE as a gold standard

To evaluate the ability of USG & MRI to determine which imaging features are predictive of malignancy.

INCLUSION CRITERIA:

Simple adnexal cyst >5cm

Complex adnexal lesions

EXCLUSION CRITERIA:

Simple adnexal cyst <5cm

Ectopic pregnancy

Ovarian torsion

MRI contraindicated patients – pace maker, joint implant prosthesis

MATERIALS AND METHODS

At our institution female patients presenting with lower abdominal pain and menstrual irregularities are evaluated in Department of Obstetrics and Gynaecology and then referred to Department of Radiodiagnosis for radiological evaluation.

Forty five patients were referred for evaluation of Ultrasonography and contrast MRI . The patients were first subjected to ultrasound then dynamic MR imaging was done for those adnexal lesions greater than 5 cm in size .The study was conducted after obtaining proper informed consent from the patient. As this was a prospective controlled study, ethical committee approval from Institutional Ethics Committee, Kilpauk Medical College, was obtained.

All patients are subjected to Transabdominal sonography using curvilinear probe in Aloka,Sonoscape,Esoate scanner

In Ultrasonogram adnexal lesions were evaluated for several features including content, nodularity , wall thickness , septal thickness , ascites and vascularity of the lesion

Then these patients are subjected to MRI and the following imaging features are evaluated.

The Dynamic MR imaging features documented for evaluation include the lesion size, content of lesion (solid only, mainly solid, solid–cystic, mainly cystic, and cystic only), wall thickness, nodularity, septal thickness, early arterial phase enhancement, ascites, omental deposits and lymphadenopathy

STUDY DESIGN

All patients are subjected to Transabdominal sonography using curvilinear probe in Aloka, Sonoscape, Esoate scanner. Axial and sagittal Images of adnexal mass lesions are taken and then colour Doppler images also taken.

The patients were subjected to magnetic resonance imaging using 1.5 Tesla GE. The patients were examined in supine position and following sequences were taken:

T1 axial

T2 sagittal, coronal

STIR coronal

T1 contrast axial and coronal

Tesla (GE) machine was used. The following sequences were used:

1. T2 W Axial

   TR: 7120 ms,

   TE: 90 ms,

   Flip angle 90*

   Slice thickness 5mm,

   Matrix 256 x 256

2. T1 W Axial

   TR: 740 ms,

   TE: 13 ms,

   Flip angle 90*

   Slice thickness 5mm,

   Matrix 256 x 256

3. STIR:

   TR: 6000 ms,

   TE: 70ms,

   TI : 230 ms

   Slice thickness 4 mm,

   Matrix 256 x 256

4.Contrast enhanced T1 images:

Contrast-enhanced images were obtained after IV injection of 10 ml gadolinium.

The dynamic contrast-enhanced fat-suppressed T1-weighted MR imaging was performed through the lesion in the optimal plane

This sequence was performed before and immediately after a rapid hand

IV injection of 10ml of gadolinium and then repeated at 30, 60, 90, and 120 sec.

TR: 900

TE:15

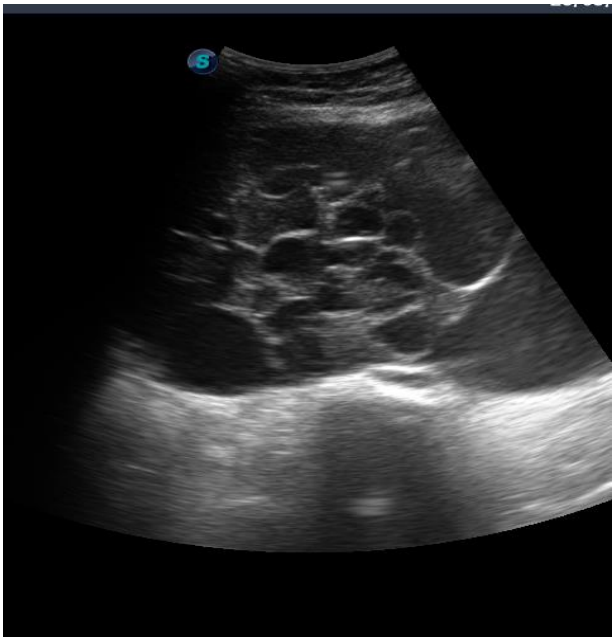
Flip angle: 90 degree

Slice thickness: 4mm

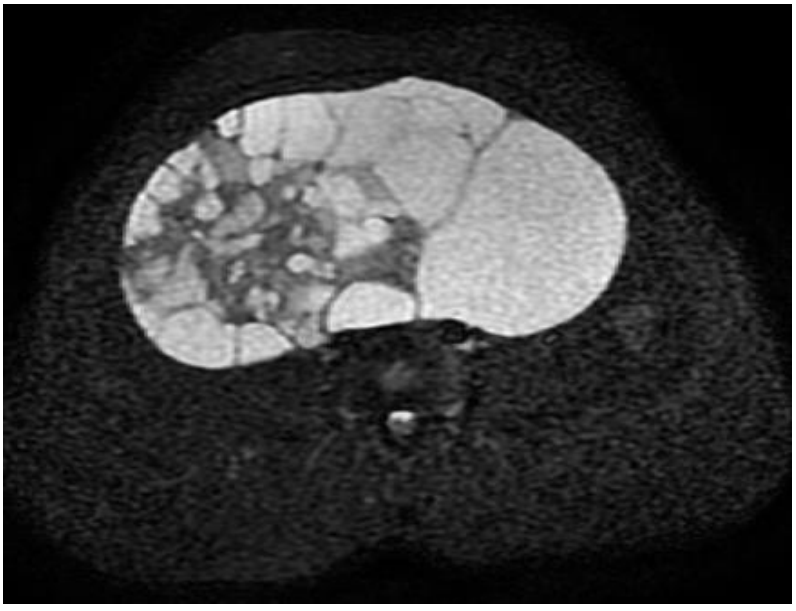
Matrix: 256x320

CASES

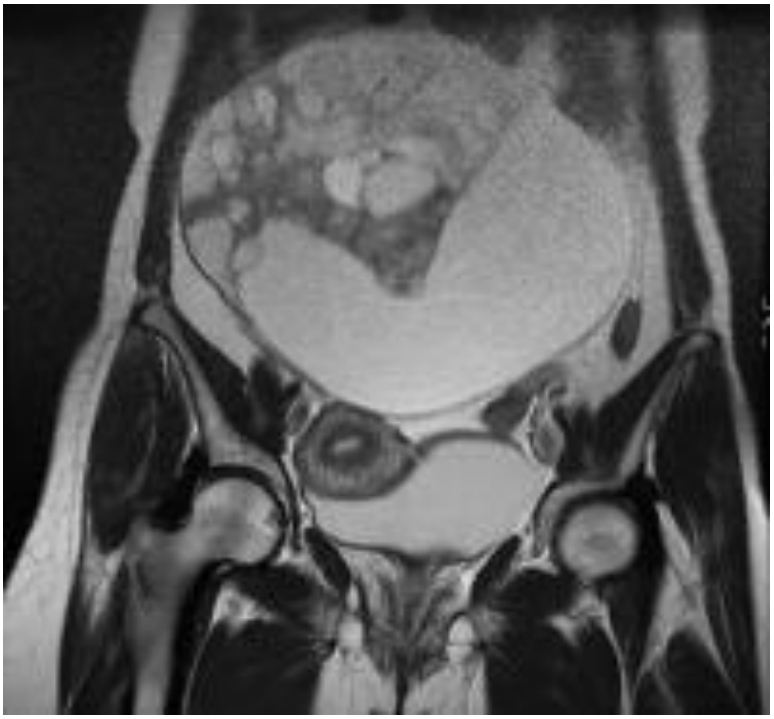
Case 1: 38 years female patient presented with lower abdominal pain



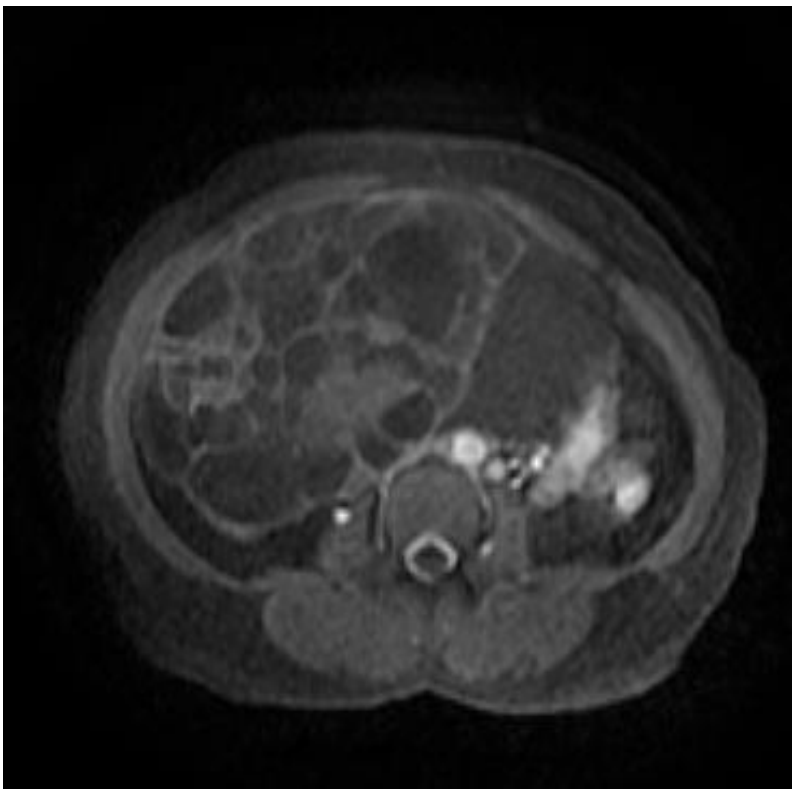
USG shows well defined cystic lesion with multiple septations and nodularity – Malignant



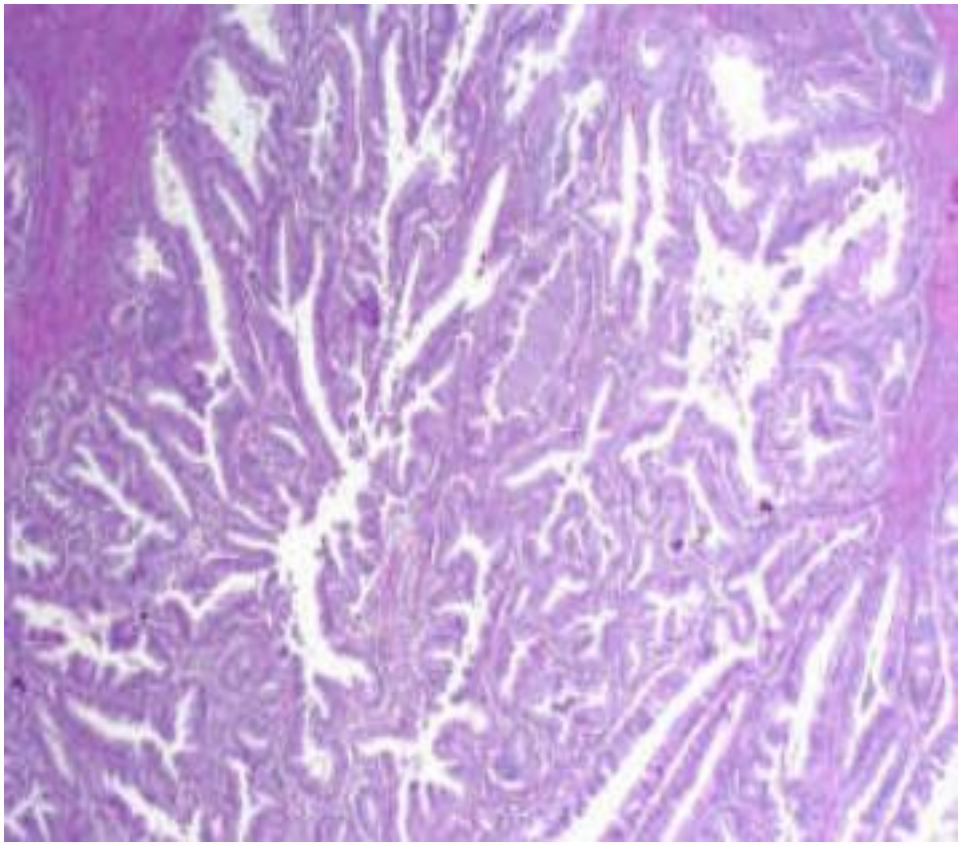
STIR images shows cystic lesion with septation and nodularity



T2W images hyperintense lesion with septation and nodularity



Post contrast TI images shows septal and nodular enhancement - Malignant

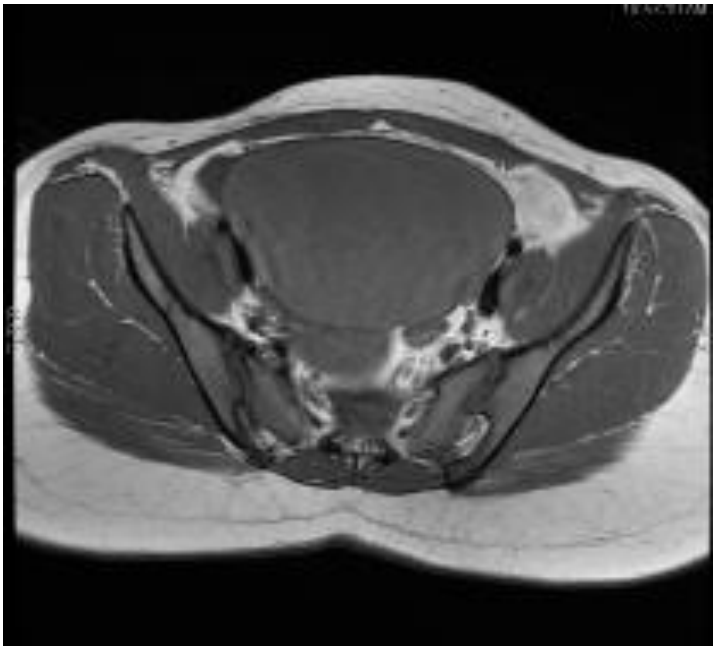


HPE : Mucinous cystadenocarcinoma

CASE 2

32 years female patient presented with lower abdominal pain.

USG shows well defined cystic lesion in adnexa - Benign



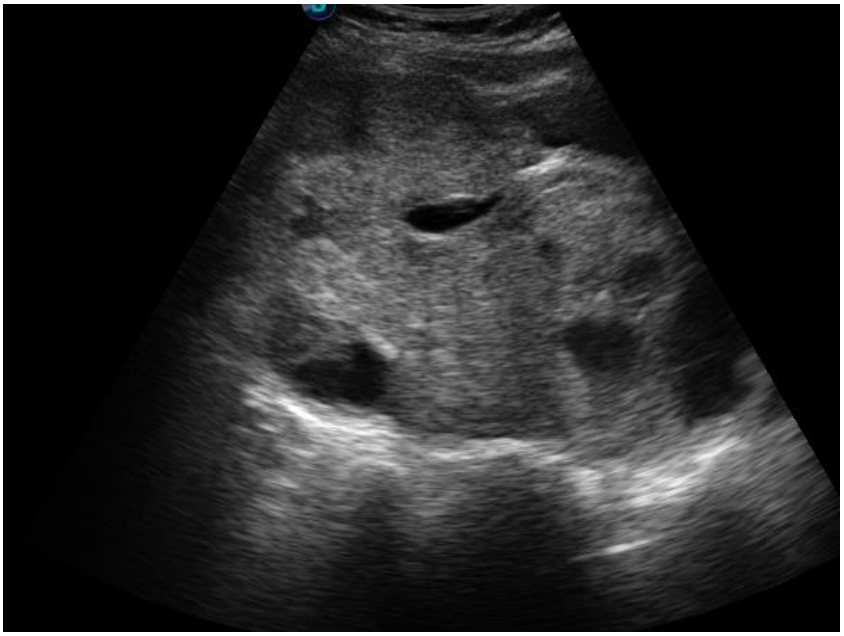
Well defined T1- Hypointense cystic lesion in adnexa

Well defined T2-Hyperintense cystic lesion in adnexa - Benign

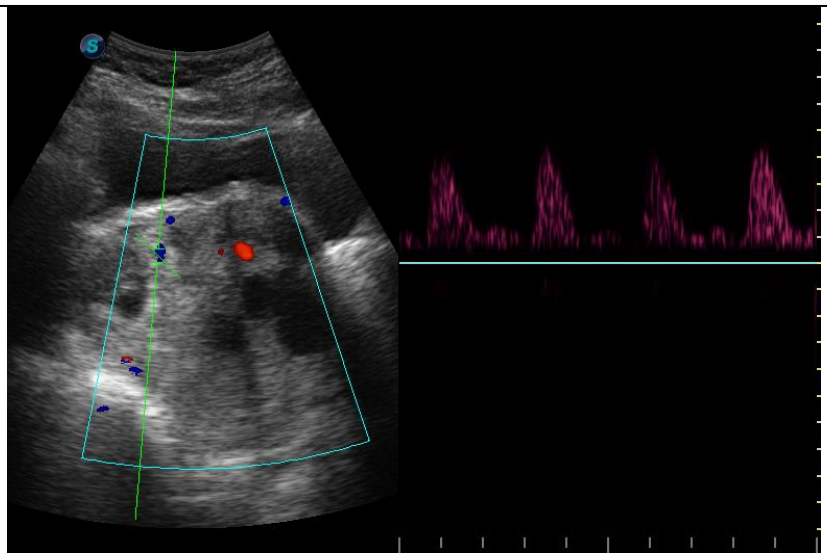
HPE: Serous cyatadenoma

CASE 3

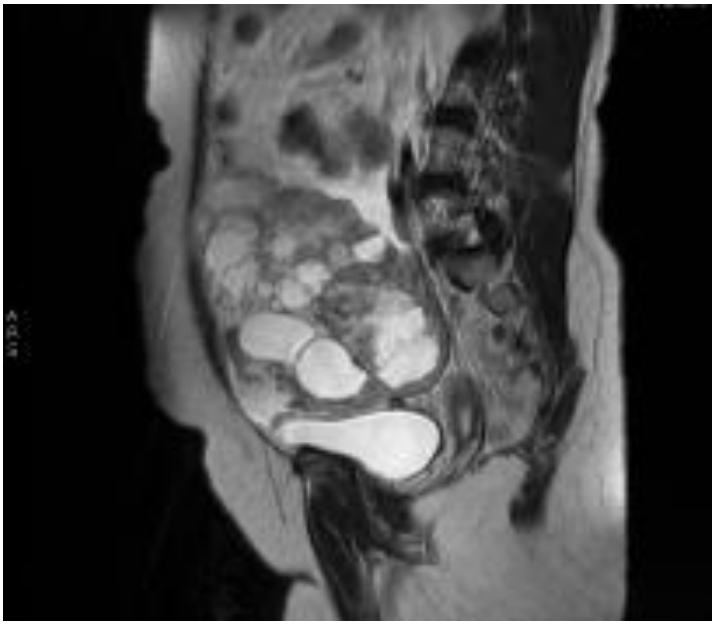
21 years female patient presented with abdominal pain and menstrual irregularities.



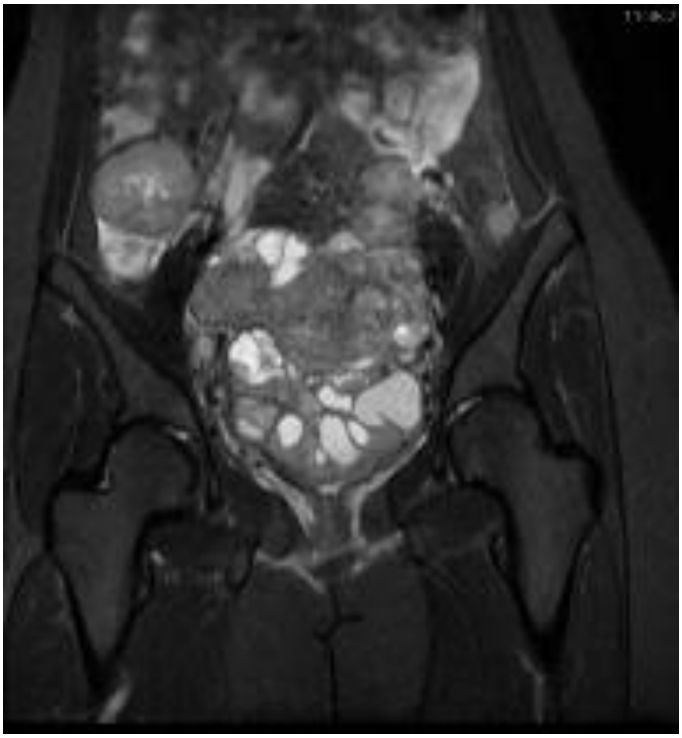
USG shows heteroechoic lesion in bilateral adnexa

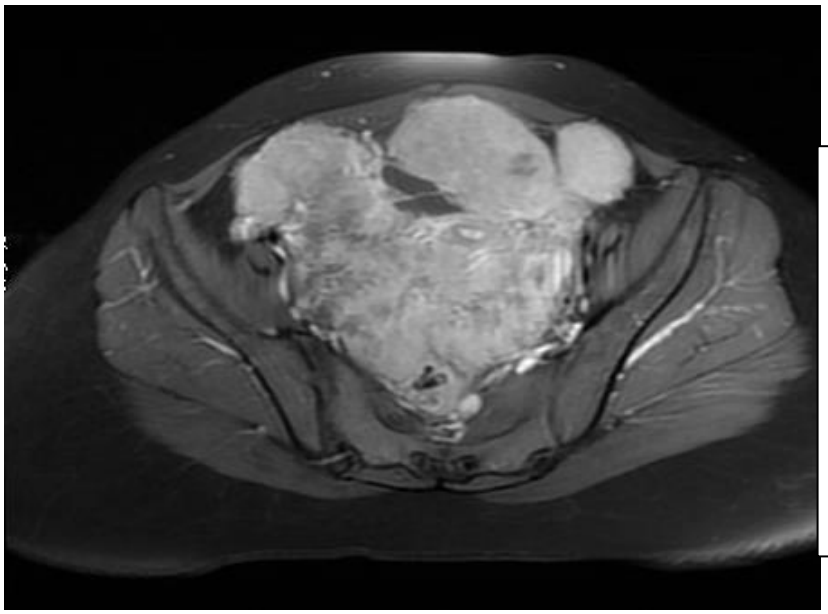


USG Doppler shows central vascularity - Malignant



T2 &STIR
Herointense lesion with cystic and solid component noted in bilateral adnexa with omental deposits.



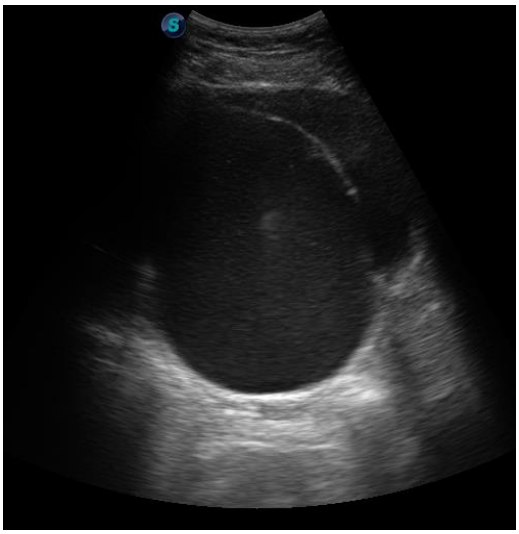


Post contrast TI sequence shows intense enhancement of the lesion Mailgnant

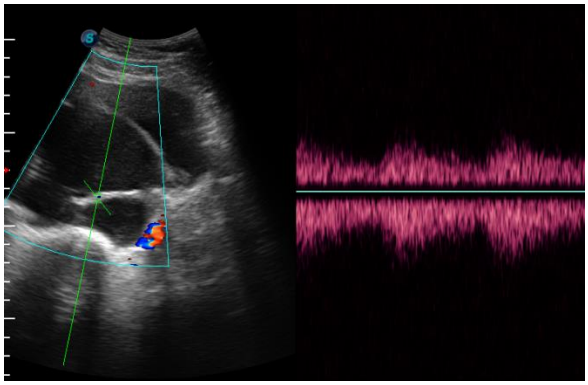
HPE : Surface epithelial malignant tumor

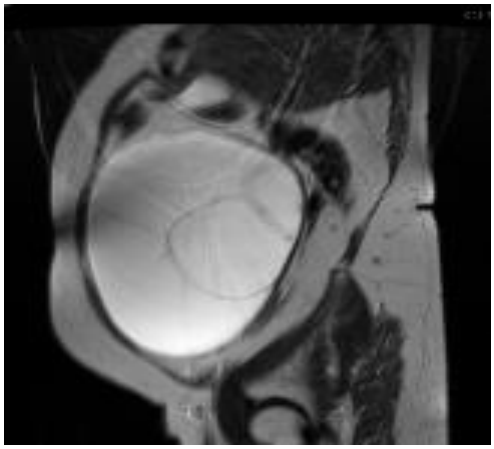
CASE 4

45 years female patient presented with abdominal pain and menstrual irregularities.

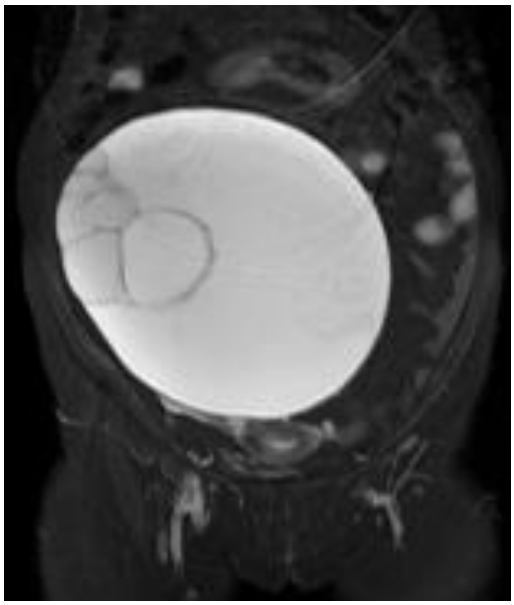


Well defined cystic lesion with septation in adnexa with peripheral vascularity - Benign

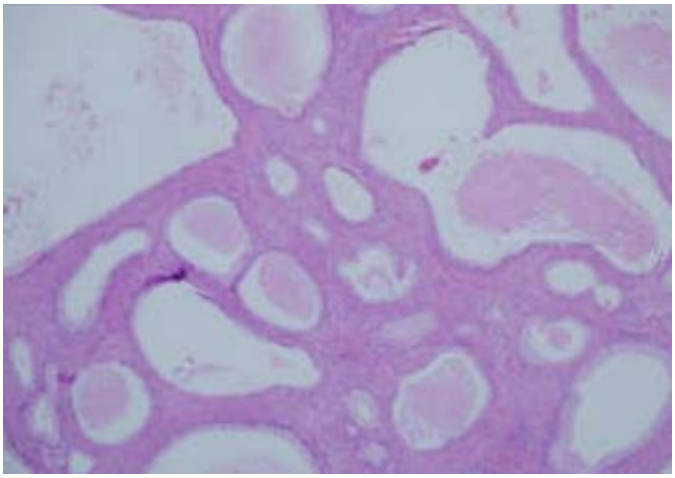




Well defined T2 Hyperintense lesion with septation in adnexa - Benign



Well defined STIR Hyperintense cystic lesion with septation in adnexa

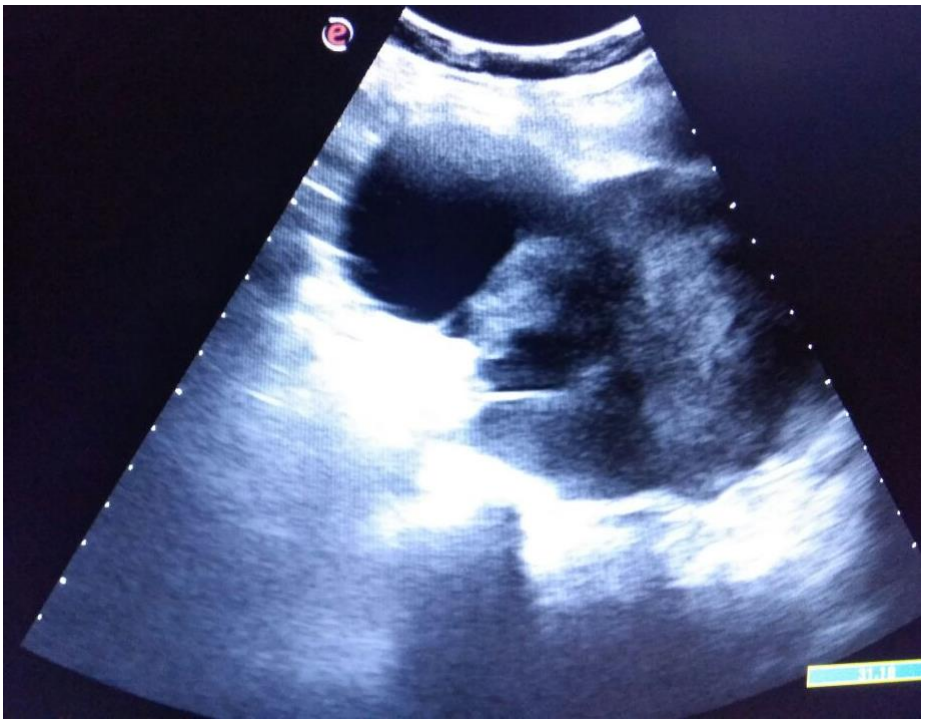


Variably-sized cysts and glands separated by fibrous septa. The septa vary in thickness and are lined by intestinal (more common) orendocervical epithelium.

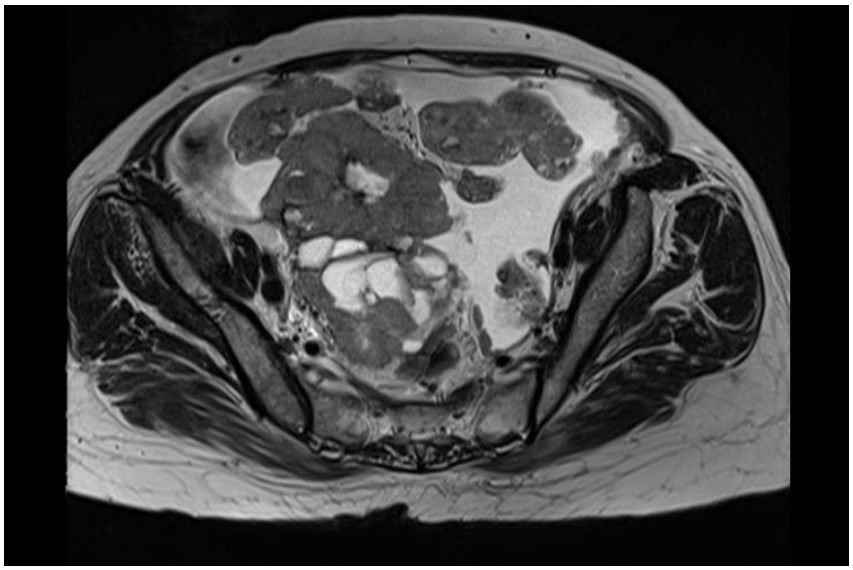
HPE : Mucinous cystadenoma

CASE 5

45 years female patient presented with abdominal pain.

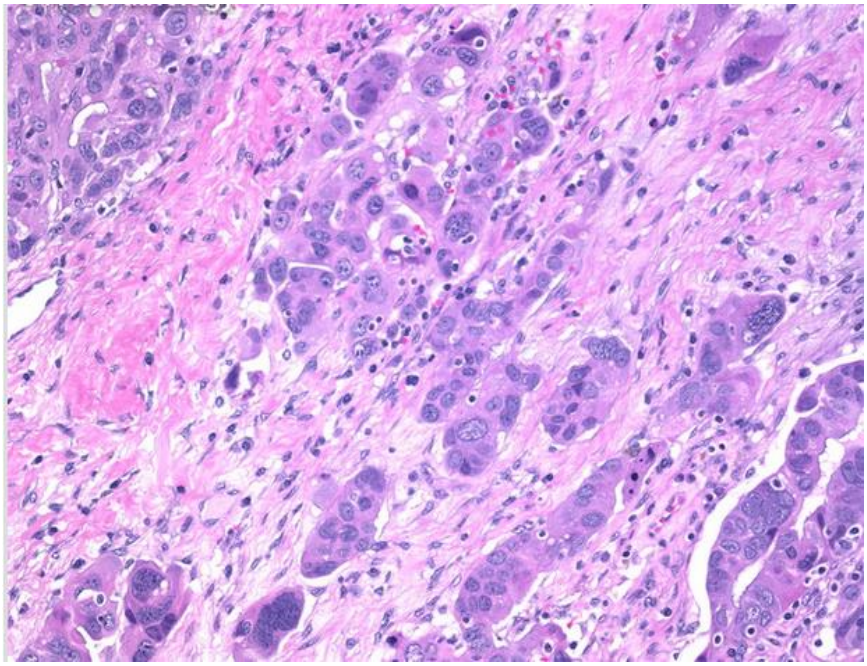


Cystic lesion with solid component noted in adnexa - Mailgnant



T2 Heteriontense lesion with cystic & solid component in bilateral adnexa

STIR Heterointense lesion with cystic & solid component in bilateral adnexa with multiple omental deposits and ascites - Mailgnant.



High-grade tumor cells arranged in nests and clusters infiltrating the ovarian stroma.

HPE: serous papillary cystadenocarcinoma

RESULTS AND STATISTICAL ANALYSIS

The collected data were analysed with IBM.SPSS statistics software 23.0 Version. To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables.

Bar chart and pie chart also used for statistical analysis.

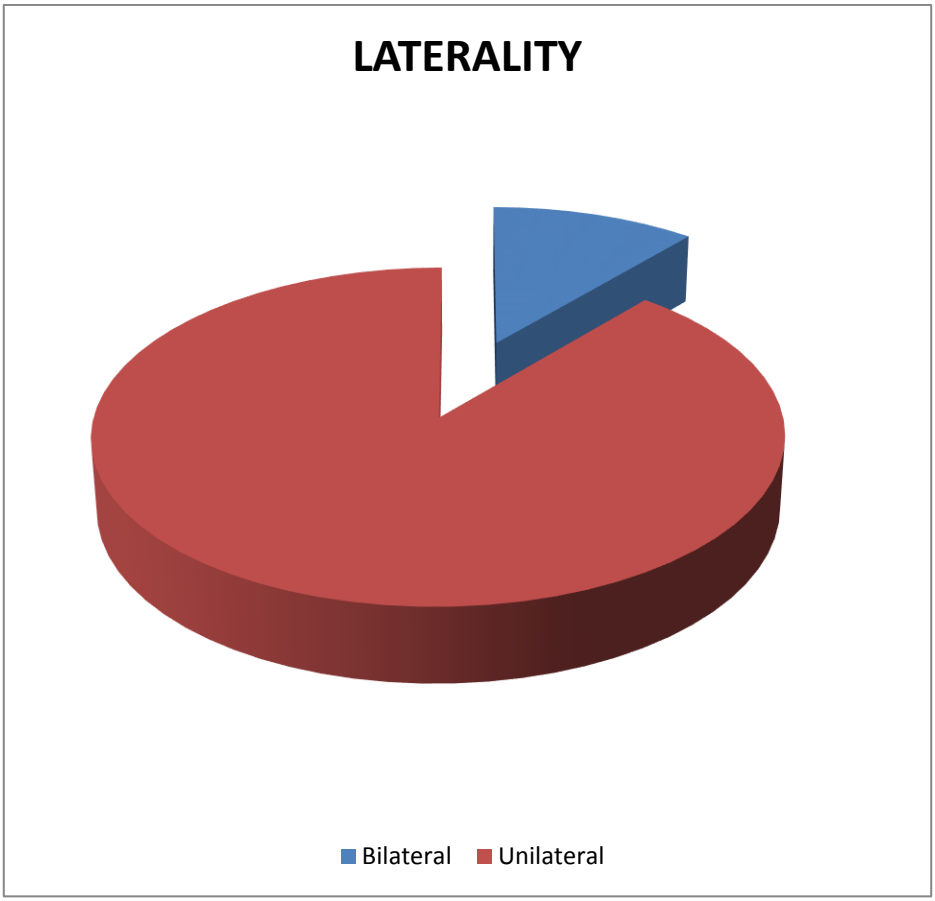
The Receiver Operator Characteristic (ROC) curve analysis was used to find the Sensitivity ,Specificity ,PPV and NPV on comparison of USG and MRI with HPE.

In the above statistical tool the probability value .05 is considered as significant level.

DESCRIPTIVE STATISTICS

Charecteristics	N	Minimum	Maximum	Mean	Std. Deviation
Age	45	16	76	37.64	12.617
Thickness USG	26	2	4	2.992	0.5699
RI USG	27	0.4	0.9	0.6844	0.16173
Thickness MRI	26	2	4	3.304	0.5674
Valid N (listwise)	26				

BILATERAL / UNILATERAL ADNEXAL MASS LESIONS		
	Frequency	Percent
Bilateral	5	11.9
Unilateral	40	88.1
Total	45	100



USG

CONTENT – USG		
Nature of lesion	Frequency	Percent
Cystic	38	84.4
Solid-cystic	7	15.6
Total	45	100

NODULE – USG		
	Frequency	Percent
Absent	40	88.9
Present	5	11.1
Total	45	100

ASCITES – USG		
	Frequency	Percent
Absent	40	88.9
Present	5	11.1
Total	45	100

VASCULARITY – USG		
	Frequency	Percent
Absent	20	44.4
Central vascularity	7	15.6
Peripheral vascularity	13	28.9
Septal vascularity	5	11.1
Total	45	100

SEPTUM CHARECTERISTICS – USG		
	Frequency	Percent
Absent	19	42.2
Present	26	57.8
Total	45	100

MRI

CONTENT IN MRI		
Nature of lesion	Frequency	Percent
Cystic	38	84.4
Solid-cystic	7	15.6
Total	45	100

NODULE – MRI		
	Frequency	Percent
Absent	38	84.4
Present	7	15.6
Total	45	100

SEPTUM CHARECTERISTICS – MRI		
	Frequency	Percent
Absent	19	42.2
Present	26	57.8
Total	45	100

ENHANCEMENT – MRI		
	Frequency	Percent
Enhancement	11	26.7
No enhancement	34	73.3
Total	45	100

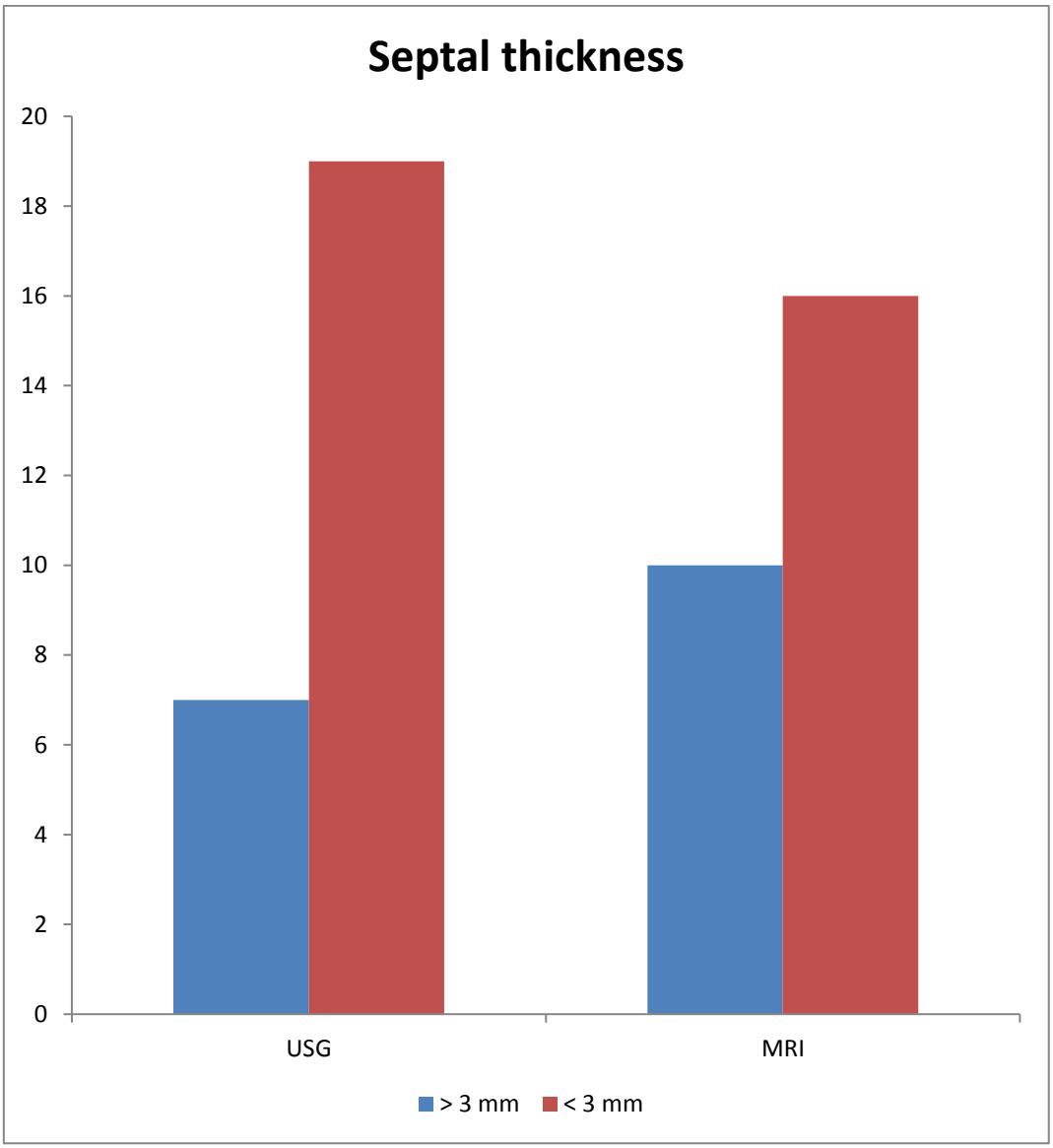
ASCITES – MRI		
	Frequency	Percent
Absent	40	88.9
Present	5	11.1
Total	45	100

OMENTAL DEPOSITS – MRI		
	Frequency	Percent
Absent	41	91.1
Present	4	8.9
Total	45	100

LYMPHADENOPATHY – MRI		
	Frequency	Percent
Absent	42	93.3
Present	3	6.7
Total	45	100

USG vs MRI

Septal thickness charecteristics



USG		
	Frequency	Percent
+ ve	7	15.6
- ve	38	84.4
Total	45	100

MRI		
	Frequency	Percent
+ ve	11	24.4
- ve	34	75.6
Total	45	100

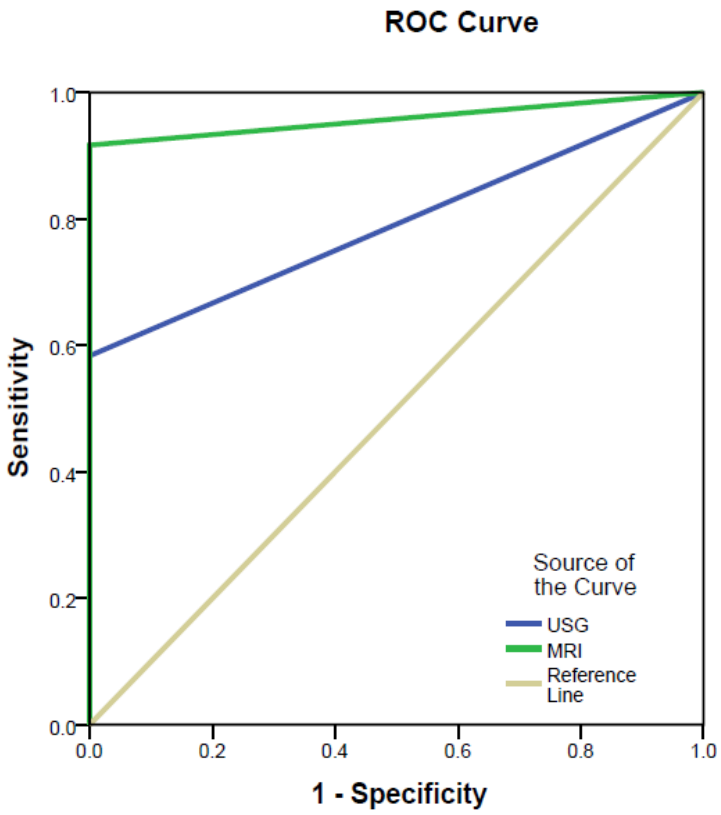
HPE		
	Frequency	Percent
+ ve	12	26.7
- ve	33	73.3
Total	45	100

USG * HPE Cross tabulation				
		HPE		Total
		+ ve	- ve	
USG	+ ve	7	0	7
	- ve	5	33	38
Total		12	33	45

VARIABLES	PERCENTAGE
Sensitivity	58.3
Specificity	100
PPV	100
NPV	86.8
Over all Accuracy	79.15

MRI * HPE Crosstabulation				
		HPE		Total
		+ ve	- ve	
MRI	+ ve	11	0	11
	- ve	1	33	34
Total		12	33	45

VARIABLES	PERCENTAGE
Sensitivity	91.7
Specificity	100
PPV	100
NPV	97.1
Over all Accuracy	95.8



ROC Curve	
Case Processing Summary	
HPE	Valid N (list wise)
Positive[a]	12
Negative	33

Smaller values of the test result variable(s) indicate stronger evidence for a positive actual state.

a. The positive actual state is + ve.

AREA UNDER THE CURVE					
Test Result Variable(s)	Area	Std. Error[a]	Asymptomatic Sig.[b]	Asymptomatic 95% Confidence Interval	
				Lower Bound	Upper Bound
USG	.792	.092	.003	.611	.973
MRI	.958	.047	.000	.866	1.000

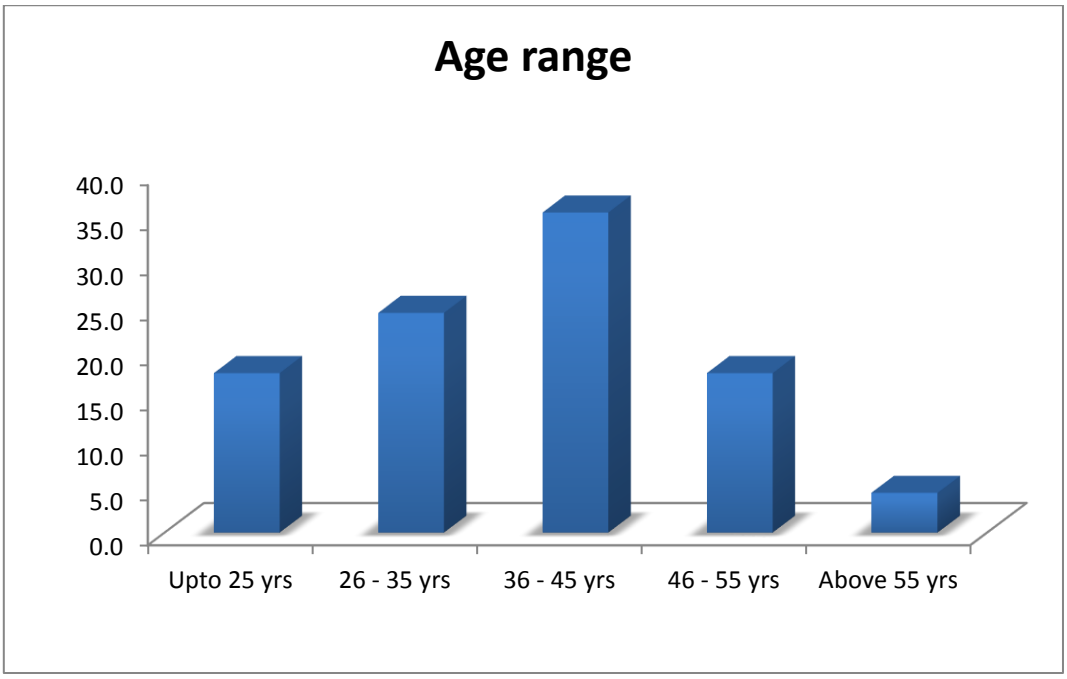
The test result variable(s): USG, MRI has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

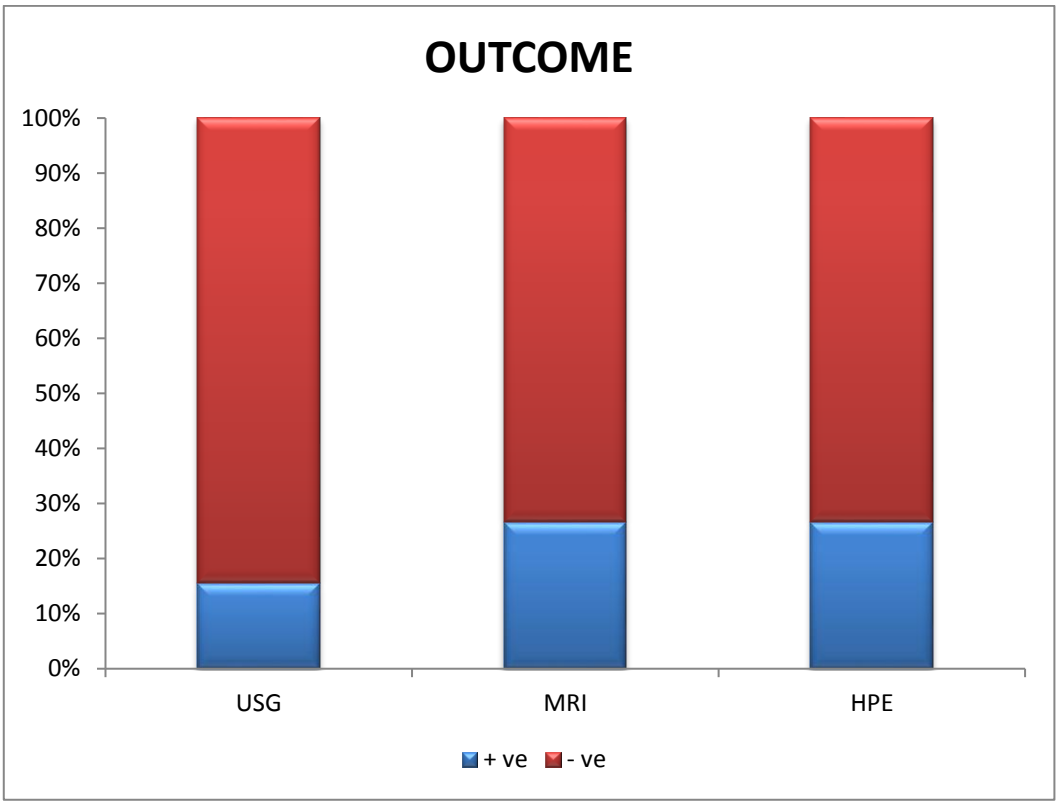
a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

P- value is highly significant <0.01

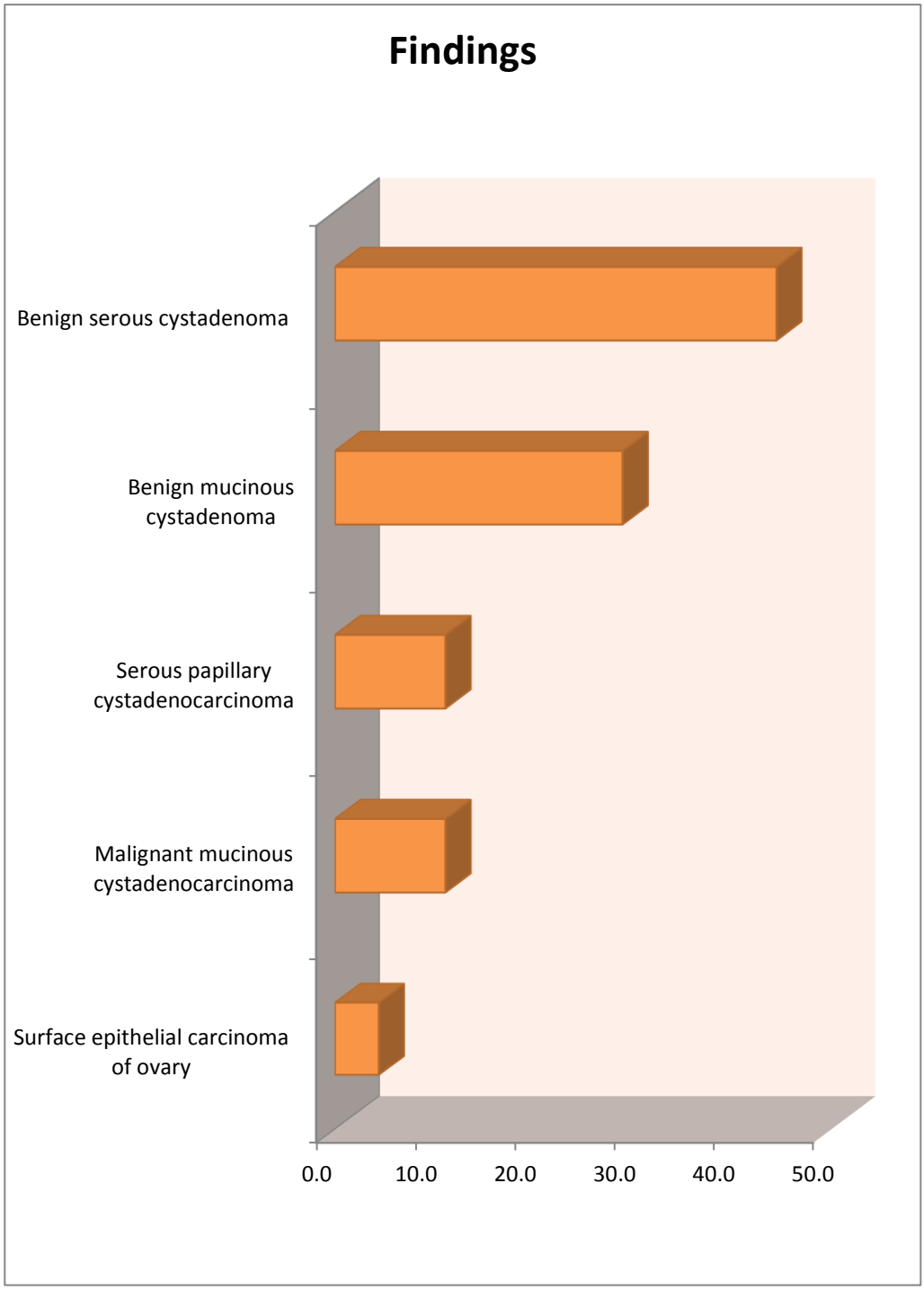
Age range					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Upto 25 yrs	8	17.8	17.8	17.8
	26 - 35 yrs	11	24.4	24.4	42.2
	36 - 45 yrs	16	35.6	35.6	77.8
	46 - 55 yrs	8	17.8	17.8	95.6
	Above 55 yrs	2	4.4	4.4	100.0
	Total	45	100.0	100.0	


Age range
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Upto 25 yrs
26 - 35 yrs
36 - 45 yrs
46 - 55 yrs
Above 55 yrs


OUTCOME
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
USG
MRI
HPE
+ ve
- ve

Ovarian Tumors	Frequency	Percentage
Benign serous cystadenoma	20	44.4
Benign mucinous cystadenoma	13	28.9
Surface epithelial carcinoma of ovary	2	4.4
Malignant mucinous cystadenocarcinoma	5	11.1
Serous papillary cystadenocarcinoma	5	11.1

Ovarian Tumors	Findings
Surface epithelial carcinoma of ovary	4.4
Malignant mucinous cystadenocarcinoma	11.1
Serous papillary cystadenocarcinoma	11.1
Benign mucinous cystadenoma	28.9
Benign serous cystadenoma	44.4


Findings
Benign serous cystadenoma
Benign mucinous cystadenoma
Serous papillary cystadenocarcinoma
Malignant mucinous cystadenocarcinoma
Surface epithelial carcinoma of ovary
0.0
10.0
20.0
30.0
40.0
50.0

DISCUSSION

The age group examined in our study was from 16-76 years..Among these the incidence of adnexal lesions were found to be more in the age group of 36-45 years and followed by 26-35 years.

Among these 45 patients, 5 had bilateral lesions and on HPE, all of these lesions were confirmed to be malignant.

In Ultrasonogram adnexal lesions were evaluated for several features including content, nodularity , wall thickness , septal thickness , ascites and vascularity of the lesion.

In our study group solid cystic nature of the lesion was seen in 15.6% (5 cases), Septal thickness > 3mm in 7 cases , nodularity was seen in 11.6% (5 cases) and central / septal vascularity was seen in 26.7%(12cases).

Among these, all the cases having central and septal vascularity were found to be malignant.

The Dynamic MR imaging features documented for evaluation include the lesion size, content of lesion (solid only, mainly solid, solid–

cystic, mainly cystic, and cystic only), wall thickness , nodularity , septal thickness, early arterial phase enhancement, ascites , omental deposits and lymphadenopathy.

Solid – cystic nature of the lesion was seen in 15.6% (5 cases) , septal thickness >3mm was seen in 11 cases, nodularity was seen in 15.6% and early arterial phase enhancement was seen in 26.7% (11 case) are highly indicative of malignant ovarian tumors.

The study included 45 patients with adnexal mass lesions. On Ultrasonogram there were 38 cases of benign ovarian lesions and 7 cases of malignant ovarian tumors. MR imaging studies of 45 patients showed 33 cases to be of benign nature and 11 cases to be of malignant nature. Histopathological studies of postoperative specimens revelaed 33 cases to have benign tumor and 12 cases to have malignant features.

Sohaib et al. (34) showed that from the analysis of the MR imaging features, “the most predictive characteristics of malignancy are vegetations/nodule in a cystic lesion, presence of ascites, a maximal diameter greater than 6 cm, and necrosis in a solid lesion” ,in the same way our study also shows the presence of nodules in a cystic lesion,

presence of ascites and lesion size more than 6 cm suggestive of malignancy.

Valentini et al.(28) suggested criteria for characterization of suspicious adnexal lesions.Features suggestive of malignancy as per the valentine et al study were “solid, solid/cystic enhancing masses (greater than 4 cm in maximum diameter) with papillary projections and irregular thick wall and septa greater than 3 mm) into a cystic lesion” as well as a “heterogeneous and early enhancement pattern”. Similar to this study , the above features in our study population also had positivity for malignancy in HPE.

Adumusili et al (29) study have high specificity (94%) for establishing a benign diagnosis. The specificity in our study is 100%.

Guerra et al study (27) on MRI had a higher accuracy of 95% in differentiating between malignant and non-malignant adnexal lesions. The diagnostic accuracy of our study is 95% similar to Guerra et al.

Adumusili et al study (29) showed Sonographically indeterminate ovarian mass lesions evaluated with MRI had a sensitivity and specificity of 100% and 94%, respectively. Result of our study MRI had a sensitivity of 91.7% and specificity of 100%

Sohaib et al study (34) showed overall diagnostic accuracy of 91% for distinguishing MR imaging features of benign from malignant adnexal lesions . the results of our study show that the overall diagnostic accuracy of 95% for distinguishing benign from malignant adnexal lesions.

Features that were shown not to be significantly different between benign and malignant masses in our study were wall thickness and size of the lesion.

The one malignant lesion not detected in dynamic MR imaging was low grade mucinous cystadenocarcinoma. This lesion did not show septal enhancement in post contrast study. Five malignant lesions not detected in ultrasonogram includes 4 cases of mucinous cystadenocarcinoma and 1 case of serous papillary cystadenocarcinoma. In all these 5 cases septal thickness was less than 3mm and nodularity was absent.

In MRI characterization of adnexal mass lesions, enhancement of lesion , septal thickeness >3mm, nodularity of the lesion and ascites are highly suggestive of malignant nature of the lesion.

In Ultrasonographic characterization of adnexal mass lesions, septal thickness, nodularity, central and peripheral vascularity of the lesion are highly suggestive of malignancy

The sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy of Ultrasonogram in comparison with HPE were 58.3%, 100%, 100%, 86.8.5%, 79.15% respectively.

In comparison with HPE , characterization of the detected lesions as malignant, MR imaging had a sensitivity of 91.7% , specificity of 100% , positive predictive value of 100% , a negative predictive value of 97.1% , and an overall accuracy of 95.8% .

CONCLUSION

Inspite of development in advanced chemotherapy regimens and improved surgical approaches, ovarian carcinoma continues to be one of the leading cause of death from gynaecological malignancy.

Treatment of adnexal mass lesion mandates stratification of risk based on imaging appearance of the mass.

Ultrasonography is the initial imaging modality of choice for evaluation of adnexal mass lesions. But evaluation with MRI is highly accurate for identifying the origin of a mass, characterizing its tissue content and staging & preoperative plan..

Sensitivity and diagnostic accuracy for MRI is higher than USG.

MRI is superior to Ultrasonogram in diagnosing and characterizing adnexal mass lesions. High accuracy of MRI contributes to preoperative planning of a sonographically indeterminate mass.

BIBLIOGRAPHY

1. https://link.springer.com/content/pdf/10.1007/978-3-319-08066-6_1.pdf
2. https://www.researchgate.net/publication/11261998-detectionandcharacterisationofadnexalmass
3. https://www.ncbi.nlm.nih.gov/pubmed/26894303
4. Ghossain MA, Buy JN, Ligneres C, et al. *Epithelial tumors of the ovary: comparison of MR and CT findings. Radiology* 1991; 181:863-870. Link
5. Buy JN, Ghossain MA, Sciot C, et al. *Epithelial tumors of the ovary: CT findings and correlation with US. Radiology* 1991; 178:811-818. Link
6. https://www.cancer.org/cancer/ovarian-cancer/treating.html
7. Bdchaurasia human anatomy,regional and applied, dissection and clinical, volume 2- lower limb and abdomen &pelvis 4th edition
8. .grays henry anatomy 41 st edition
9. .cunningham DJ.Cunninghams text book of anatomy.
10. Bardo DM, Black M, Schenk K, Zaritzky MF (2009) Location of the ovaries in girls from newborn to 18 years of age:reconsidering ovarian shielding. Pediatr Radiol 39:253–259
11. Moore KL, Persaud TVN (1998) The urogenital system. In:Moore KL, Persaud TVN (eds) The developing human.Clinically oriented embryology, ed 6. WB Saunders,Philadelphia, pp 303–347
12. Verkauf BS, Bernhisel M (1996) Ovarian maldescent. Fertil Steril 65:189–192

13. Thompson D, Easton DF. Cancer incidence in BRCA 1 mutation carriers. J Natl Cancer Inst.2002;94:1358–1365
14. Lacey JV, Mink PJ, Lubin JH, et al. Menopausal hormone replacement therapy and risk of ovarian cancer. JAMA. 2002; 288:334–341
15. The breast Cancer Linkage Consortium. Cancer risk in BRCA2 mutation carriers. J Natl Cancer Inst.1999;91:1310–1316
16. Willner J, Wurz K, Allison KH, Galic V, Garcia RL, Goff BA, Swisher EM. Alternate molecular genetic pathways in ovarian carcinomas of common histological types. Hum Pathol. 2007
17. Singer G, Oldt R, 3rd, Cohen Y, Wang BG, Sidransky D, Kurman RJ, Shih IeM.
18. Merajver SD, Pham TM, Caduff RF, Chen M, Poy EL, Cooney KA, Weber BL, Collins FS, Johnston CM, Frank TS. Somatic mutations in the BRCA1 gene in sporadic ovarian tumours. Nat.Genet. 1995;9:439–443
19. Vogelstein B, Kinzler KW. Cancer genes and the pathways they control. Nat Med. 2004;10:789–799.
20. www.cancerresearchuk.org
21. Maggino T, Gadducci A, D'Addario V, et al. *Prospective multicenter study on CA 125 in postmenopausal pelvic masses.Gynecol Oncol* 1994; 54:117-123.
22. Togashi K. Ovarian cancer: the clinical role of US, CT, and MRI. Eur Radiol. 2003;13 Suppl 4:L87–104.
23. http://www.ajronline.org/doifull/10.2214/ajr.09.3522
24. Kinkel K, Lu Y, Mehdizade A, Pelte MF, Hricak H. Indeterminate ovarian mass at US: incremental value of second imaging test for

characterization--meta-analysis and Bayesian analysis. Radiology. 2005;236:85–94

25. Reles A, Wein U, Lichtenegger W. *Transvaginal color Doppler sonography and conventional sonography in the preoperative assessment of adnexal masses. J Clin Ultrasound* 1997; 25:217-225.

26. Kurtz AB, Tsimikas JV, Tempany CM, et al. *Diagnosis and staging of ovarian cancer: comparative values of Doppler and conventional US, CT, and MR imaging correlated with surgery and histopathologic analysis—report of the Radiology Diagnostic Oncology Group. Radiology* 1999; 212:19-2

27. Hricak H, Chen M, Coakley FV, Kinkel K, Yu K, Sica G, et al. Complex adnexal masses: detection and characterization with MR imaging _ multivariate analysis. Radiology 2000; 214: 39_46.

28. Valentini AL, Gui B, Miccò M, Mingote MC, De Gaetano AM, Ninivaggi V, et al. Benign and suspicious ovarian masses-MR imaging criteria for characterization: pictorial review. J Oncol.2012;2012:481806

29. Adusumilli S, Hussain HK, Caoili EM, Weadock WJ, Murray JP, Johnson TD, Chen Q, Desjardins B. MRI of sonographically indeterminate adnexal masses. AJR Am J Roentgenol. 2006;187:732–740

30. van Vierzen PB, Massuger LF, Ruys SH, Barentsz JO. Borderline ovarian malignancy: ultrasound and fast dynamic MR findings. Eur J Radiol 1998;28:136–142

31. Saini A, Dina R, McIndoe GA, Soutter WP, Gishen P,deSouza NM. Characterization of adnexal masses with MRI. Am J Roentgenol 2005; 184: 1004_9.
32. Kawamoto S, Urban BA, Fishman EK. CT of epithelial ovarian tumors. Radiographics. 1999;19
33. Jeong YY, Outwater EK, Kang HK. *Imaging evaluation of ovarian masses*. *RadioGraphics* 2000; 20:1445-1470
34. Sohaib SA, Sahdev A, Van Trappen P, Jacobs IJ,Reznek RH. Characterization of adnexal mass lesions on MR imaging. Am J Roentgenol 2003; 180: 1297_304.
35. www.pathologyoutlines.com/topic/ovarytumourwhoclassif.html
36. Occhipinti KA. *Computed tomography and magnetic resonance imaging of the ovary*. In: Anderson JC, eds. *Gynecologic imaging*. London, England: Churchill Livingstone, 1999; 345-359.
37. Jung SE, Lee JM, Rha SE, Byun JY, Jung JI, Hahn ST. CT and MR imaging of ovarian tumors with emphasis on differential diagnosis. Radiographics. 2002;22:1305–1325
38. Shaaban AM, Rezvani M, Elsayes KM, Baskin H, Jr, Mourad A, Foster BR, et al. Ovarian malignant germ cell tumors: cellular classification and clinical and imaging features. Radiographics. 2014;34(3):777–801.
39. Imaoka I, Wada A, Kaji Y, Hayashi T, Hayashi M, Matsuo M, et al. Developing an MR imaging strategy for diagnosis of ovarian masses. Radiographics. 2006;26(5):1431–48. doi: 10.1148 /rg .265045206.

40. Iyer VR, Lee SI. MRI, CT, and PET/CT for ovarian cancer detection and adnexal lesion characterization.AJR Am J Roentgenol. 2010;194(2):311 21

41. Cai SQ, Zhao SH, Qiang JW, Zhang GF, Wang XZ, Wang L. Ovarian Sertoli-Leydig cell tumors: MRI findings and pathological correlation. J Ovarian Res. 2013;26;6(1):73. doi: 10.1186/1757-2215-6-73.

42. Tanaka YO, Yoshizako T, Nishida M, Yamaguchi M, Sugimura K, Itai Y. Ovarian carcinoma in patients with endometriosis: MR imaging findings. AJR Am J Roentgenol. 2000;175:1423–1430. [PubMed]

43. Wagner BJ, Buck JL, Seidman JD, McCabe KM. From the archives of the AFIP. Ovarian epithelial neoplasms: radiologic-pathologic correlation. Radiographics. 1994;14:1351–1374

44. Brown DL, Zou KH, Tempany CM, Frates MC, Silverman SG, McNeil BJ, et al. Primary versus secondary ovarian malignancy: imaging findings of adnexal masses in the Radiology Diagnostic Oncology Group Study. Radiology. 2001;219(1):213–8. doi: 10.1148/radiology.219.1.r01ap28213

45. Kim MY, Rha SE, Oh SN, Jung SE, Lee YJ, Kim YS, et al. MR Imaging findings of hydrosalpinx: a comprehensive review. Radiographics. 2009;29(2):495–507.

46. Siegelman ES, Oliver ER. MR imaging of endometriosis: ten imaging pearls. Radiographics.2012;32(6):1675–91.

47. Bau A et al : acute female pelvic pain; ultrasound evaluation seminars in ultrasound,CT, and MRI. 21:78-93 2000

48. Ha HK et al: MR imaging of tubo-ovarian abscess.acta Radiol.36(5) : 510-4,1995
49. https://www.ajronline.org/doi/abs/10.2214/ajr.15.15199
50. https://www.hindawi.com/journals/jo/2012/682480
51. https://www.omicsonline.org/.../transforming-the-future-of-treatment-for-ovarian-cancer
52. Jeccr.biomedcentral.com/articles/10.1186/1756-9966-31-14

LIST OF ABBREVATIONS

USG- Ultrasonography

CT - Computed Tomography

MRI – Magnetic Resonance imaging

STIR – short tau Inversion Recovery

PROFORMA

Name

Age

Sex

Address

Phone no.

Education

Occupation

General examination:

PATIENT CONSENT FORM

STUDY DETAIL :

STUDY CENTRE :

PATIENT'S NAME :

PATIENT'S AGE :

IDENTIFICATION NUMBER :

I confirm that I have understood the purpose and procedure of the above study. I have the opportunity to ask questions and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.

I understand that the sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However I understand that my identity would not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

I hereby consent to participate in this study.

I hereby give permission to undergo complete clinical examination and diagnostic tests including biochemical, radiological tests.

Signature/Thumb impression

PATIENT'S INFORMATION SHEET

Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to image the anatomy and the physiological processes of the body in both health and disease.MRI scanners use strong magnetic fields, radio waves, and field gradients to form images of our body.

During the scan, you lie on a table that slides inside a tunnel-shaped machine. Doing the scan can take a long time from 30 minutes to 60 minutes. The scan is painless. The MRI machine makes a lot of noise.

The powerful magnetic field of the scanner can attract certain metallic objects known as ''ferromagnetic'' objects, causing them to move suddenly and with great force towards the center of the MR system. Therefore, great care is taken to prevent Ferromagnetic objects from entering the MR system room. It is vital tom remove metallic objects in advance of an MRI exam, including watches, jewellery, and items of clothing that have metallic threads or fasteners.

A contrast agent called ''gadolinium'' may be injected into a vein to help obtain a clearer picture of the area being examined. This is typically done through a small needle connected to an intravenous line that is placed in

arm or hand vein. MRI contrast agents do not contain iodine and therefore, rarely cause allergic reactions or other problems.

Ultrasonography is a diagnostic medical procedure that uses sound waves to produce images on a screen, which allows medical providers to view internal structures of the body.

You will be first subjected to ultrasonography and Dynamic contrast MR imaging to characterise your adnexal pathology and followed by postoperative correlation.

INSTITUTIONAL ETHICS COMMITTEE
GOVT. KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Protocol ID. No.06/2016 Meeting held on 19/09/2016
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A COMPARATIVE STUDY OF ACCURACY OF ULTRASONOGRAPHY AND MAGNETIC RESONANCE IMAGING FEATURES IN THE DETECTION AND CHARACTERISATION OF ADNEXAL MASS LESIONS WITH HISTOPATHOLOGICAL EXAMINATION AS A GOLD STANDARD." submitted by Dr.T.Ramya, Post Graduate in Radio Diagnosis,, Govt. Kilpauk Medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

DEAN 4/11/16.
Govt. Kilpauk Medical College,
Chennai-10

17/10/16 17/11. 4/11/16

USG FEATURES										
S.No.	**Patient name**	**Age**	**Bilateral / Unilateral**	**Content**	**Wall characteristics**	**Septum characteristics**	**Ascites**	**Doppler**		**Lesion**
				Cystic	Nodule	Thickness		Vascularity	RI	
1	Vijayalakshmi	50	unilateral	cystic	nil	3	_	nil	0.9	benign
2	Govindammal	45	unilateral	cystic	nil	2.8	_	nil	0.8	benign
3	Tamilselvi	40	unilateral	Solid - Cystic	present	4	present	central vascularity	0.55	malignant
4	Kushpoo	24	unilateral	cystic	nil	absent	_	nil		benign
5	Shanthi	53	unilateral	cystic	nil	2	_	peripheral vascularity 0.9	0.9	benign
6	Vishnupriya	21	bilateral	solid-cystic	nil	3.5	_	central vascularity	0.43	malignant
7	Sunitha	32	unilateral	cystic	nil	absent	absent	nil		benign
8	Amudha	32	unilateral	cystic	nil	absent	nil	nil		benign
9	Kaliyammal	65	unilateral	cystic	nil	2.5	nil	septal vascularity	0.6	benign
10	Amudha	32	unilateral	cystic	nil	absent	nil	peripheral vascularity	0.8	benign
11	Parvathy	45	bilateral	solid-cystic	present	3.5	present	central vascularity	0.45	malignant
12	Ranjitha	16	unilateral	cystic	nil	absent	absent	nil		benign
13	Stella mary	17	unilateral	cystic	nil	2.4	absent	peripheral vascularity	0.73	benign

14	Malarkodi	48	unilateral	cystic	nil	absent	nil	nil		benign
15	Devi	28	unilateral	cystic	nil	3	nil	peripheral vascularity	0.7	benign
16	Valliammal	76	unilateral	cystic	nil	3	nil	septal avscularity	0.65	benign
17	Kokilavani	40	unilateral	cystic	nil	absent	nil	nil		benign
18	Ammu	28	unilateral	cystic	nil	3	nil	peripheral vascularity	0.73	benign
19	Jayalakshmi	40	unilateral	cystic	nil	absent	nil	nil		benign
20	Kushpoo	24	unilateral	cystic	nil	absent	nil	nil		benign
21	Lakshmi	40	unilateral	cystic	nil	2.6		septal avscularity	0.6	benign
22	Muniyammal	42	bilateral	solid-cystic	present	3.5	present	central avscularity	0.45	malignant
23	Manimegalai	28	unilateral	cystic	nil	absent	nil	nil		benign
24	Divya	26	unilateral	cystic	nil	3	nil	peripheral vascularity	0.6	benign
25	Pushpa	18	unilateral	cystic	nil	absent	nil	nil		benign
26	Dhanalakshmi	38	bilateral	solid-cystic	present	3.5	nil	central vascularity	0.54	malignant
27	Velankanni	45	unilateral	cystic	nil	absent	nil	nil		benign
28	Thirupurasundari	50	unilateral	cystic	nil	2.9	_	peripheral vascularity	0.8	benign
29	Divya	21	unilateral	cystic	nil	absent	_	nil		benign

30	Revathy	37	unilateral	cystic	nil	3	nil	septal vascularity	0.62	benign
31	Poornima	20	unilateral	cystic	nil	3	nil	peripheral vascularity	0.75	benign
32	Eshwari	35	unilateral	cystic	nil	absent	nil	nil		benign
33	Bhuvaneshwari	47	unilateral	cystic	nil	3	nil	peripheral vascularity	0.8	benign
34	Sudhanderadevi	55	unilateral	cystic	nil	absent	nil	nil		benign
35	Muthulakshmi	45	unilateral	cystic	nil	3.2	nil	peripheral vascularity	0.9	benign
36	Usha	28	unilateral	cystic	nil	2	nil	peripheral vascularity	0.9	benign
37	Seeniyammal	40	bilateral	solid-cystic	present	4	present	central vascularity	0.4	malignant
38	Dhanalakshmi	32	unilateral	cystic	nil	2.5	nil	periphaeral vascularity	0.9	benign
39	Arunavathi	40	unilateral	cystic	nil	2	nil	peripheral vascularity	0.85	benign
40	Vijaya	50	unilateral	cystic	nil	2.9	nil	septal vascularity	0.63	benign
41	joyrita	38	unilateral	cystic	nil	absent	nil	nil		benign
42	malliga	50	unilateral	Cystic	nil	absent	nil	absent		benign
43	indhra	38	unilateral	solid-cystic	present	4	nil	central vascularity	0.5	malignant
44	amulu	35	unilateral	cystic	nil	absent	nil	absent		benign
45	sivagami	40	unilateral	cystic	nil	absent	nil	absent		benign

MRI FEATURES												
S.No.	**Patient name**	**Age**	**Bilateral / Unilateral**	**Content**	**Wall charecteristics**	**Septum characteristics**		**Enhancement**	**Ascites**	**Omental deposits**	**Lymph nodes**	**Lesion**
					Nodule	Thickness (mm)	Present					
1	Vijayalakshmi	50	unilateral	cystic	nil	3mm	nil	no enhancement	_	_	_	benign
2	Govindammal	45	unilateral	cystic	nil	3	nil	no enhancement	_	_	_	benign
3	Tamilselvi	40	unilateral	solid-cystic	present	4	present	enhancement	present	present	present	malinancy
4	Kushpoo	24	unilateral	cystic	_		absent	_	_	_	_	benign
5	Shanthi	53	unilateral	cystic		3		no enhancement	_	_	_	benign
6	Vishnupriya	21	bilateral	solid-cystic	_	3.5		intense enhancement	_	present	nil	malignant
7	Sunitha	32	unilateral	cystic	_		absent	no enhancement	_	_	_	benign
8	Amudha	32	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
9	Kaliyammal	65	unilateral	cystic	nil	2.8		septal enhancement	_	_	_	malignant
10	Amudha	32	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
11	Parvathy	45	bilateral	solid-cystic	present	3.8		solid part enhance	present	present	present	malignant
12	Ranjitha	16	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
13	Stella mary	17	unilateral	cystic	nil	2.7		no enhancement	_	_	_	benign
14	Malarkodi	48	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
15	Devi	28	unilateral	cystic	nil	3		no enhancement	_	_	_	benign
16	Valliammal	76	unilateral	cystic	present	3.5		enhancement	_	_	_	malignant
17	Kokilavani	40	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
18	Ammu	28	unilateral	cystic	nil	3		no enhancement	_	_	_	benign
19	Jayalakshmi	40	unilateral	cystic	nil		absent	no enhancemnt	_	_	_	benign
20	Kushpoo	24	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign

21	Lakshmi	40	unilateral	cystic	absent	4		septal enhancement	_	_	_	malignant
22	Muniyammal	42	bilateral	solid-cystic	present	3.5		enhancement	present	present	present	malignant
23	Manimegalai	28	unilateral	cystic	absent		absent	no enhancement	_	_	_	benign
24	Divya	26	unilateral	cystic	nil	2.8		no enhancement	_	_	_	benign
25	Pushpa	18	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
26	Dhanalakshmi	38	bilateral	solid-cystic	_	4		Enhancement	present	_	_	malignant
27	Velankanni	45	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
28	Thirupurasundari	50	unilateral	cystic	nil	2.5		no enhancement	_	_	_	benign
29	Divya	21	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
30	Revathy	37	unilateral	cystic	present	4		septal enhancement	_	_	_	malignant
31	Poornima	20	unilateral	cystic	nil	3		no enhancement	_	_	_	benign
32	Eshwari	35	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
33	Bhuvaneshwari	47	unilateral	cystic	nil	2.8		no enhancement	_	_	_	benign
34	Sudhanderadevi	55	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
35	Muthulakshmi	45	unilateral	cystic	nil	3		no enhancement	_	_	_	benign
36	Usha	28	unilateral	cystic	nil	2		no enhancement	_	_	_	benign
37	Seeniyammal	40	bilateral	solid-cystic	present	4		enhancement	present	_	_	malignant
38	Dhanalakshmi	32	unilateral	cystic	nil	3		no enhancement	_	_	_	benign
39	Arunavathi	40	unilateral	cystic	nil	3	absent	no enhancement	_	_	_	benign
40	Vijaya	50	unilateral	cystic	nil	3		septal enhancement	_	_	_	malignant
41	joyrita	38	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
42	malliga	50	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
43	indhra	38	unilateral	solid-cystic	present	4		Enhancement	_	_	_	malignant
44	amulu	35	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign
45	sivagami	40	unilateral	cystic	nil		absent	no enhancement	_	_	_	benign

HPE			
S.No.	**Patient name**	**Age**	**Findings**
1	Vijayalakshmi	50	Benign mucinous cystadenoma
2	Govindammal	45	Benign mucinous cystadenoma
3	Tamilselvi	40	Serous papillary cystadenocarcinoma
4	Kushpoo	24	Benign serous cystadenoma
5	Shanthi	53	Benign mucinous cystadenoma
6	Vishnupriya	21	Surface epithelial carcinoma ovary
7	Sunitha	32	Benign serous cystadenoma
8	Amudha	32	Benign serous cystadenoma
9	Kaliyammal	65	Mucinous cystadenocarcinoma
10	Amudha	32	Benign serous cysatdenoma
11	Parvathy	45	Papillary serous cystadenocarcinoma
12	Ranjitha	16	Benign serous cystadenoma
13	Stella mary	17	Benign mucinous cystadenoma
14	Malarkodi	48	Benign serous cystadenoma
15	Devi	28	Benign mucious cystadenoma
16	Valliammal	76	Low grade mucious cyastadenocarcinoma
17	Kokilavani	40	Benign serous cystadenoma
18	Ammu	28	Benign mucinous cystadenoma
19	Jayalakshmi	40	Benign serous cystadenoma
20	Kushpoo	24	Benign serous cystadenoma
21	Lakshmi	40	Low grade mucious cyastadenocarcinoma
22	Muniyammal	42	Papillary serous cystadenocarcinoma
23	Manimegalai	28	Simple serous cystadenoma
24	Divya	26	Benign mucinous cystadenoma
25	Pushpa	18	Benign serous cystadenoma
26	Dhanalakshmi	38	Surface epithelial carcinoma ovary
27	Velankanni	45	Benign serous cystadenoma
28	Thirupurasundari	50	Benign mucinous cystdenoma
29	Divya	21	Benign seous cystadenoma
30	Revathy	37	Serous papillary cystadenocarcinoma

31	Poornima	20	Benign mucinous cystadenoma
32	Eshwari	35	Benign serous cystadenoma
33	Bhuvaneshwari	47	Benign mucinous cystadenoma
34	Sudhanderadevi	55	Benign serous cystadenoma
35	Muthulakshmi	45	Benign mucinous cystadenoma
36	Usha	28	Benign mucinous cystadenoma
37	Seeniyammal	40	Serous papillary cystadenocarcinoma
38	Dhanalakshmi	32	Benign mucinous cystadenoma
39	Arunavathi	40	Benign serous cystadenoma
40	Vijaya	50	Mucinous cystadenocarcinoma
41	Joyrita	38	Benign serous cystadenoma
42	Malliga	50	Benign serous cyastadenoma
43	Indhra	38	Mucinous cystadenocarcinoma
44	Amulu	35	Benign serous cystadenoma
45	Sivagami	40	Benign serous cystadenoma